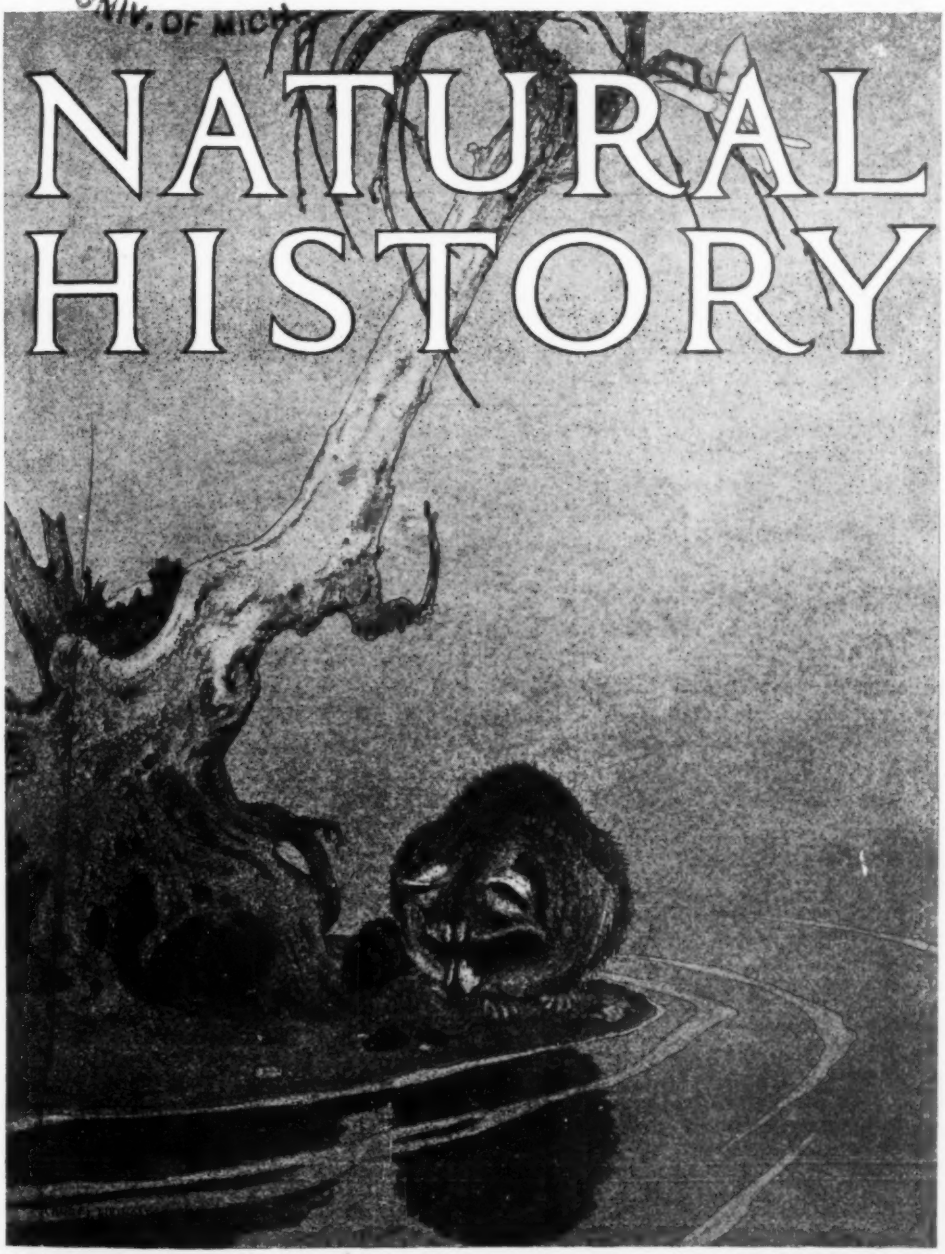
Vol. XXI JULY-AUGUST, 1921 No. 4

GENERAL LIBRARY
OCT 17 1921
UNIV. OF MICH.

NATURAL HISTORY



JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

ANNUAL SUBSCRIPTION U. S. AND CANADA $3.00 FOREIGN $3.50 SINGLE COPIES 50 CENTS

The American Museum of Natural History

BOARD OF TRUSTEES

HENRY FAIRFIELD OSBORN, President
CLEVELAND H. DODGE, First Vice President
J. P. MORGAN, Second Vice President
HENRY P. DAVISON, Treasurer
PERCY R. PYNE, Secretary
GEORGE F. BAKER
GEORGE F. BAKER, JR.
FREDERICK F. BREWSTER
THOMAS DEWITT CUYLER
WALTER DOUGLAS
CHILDS FRICK
MADISON GRANT
WILLIAM AVERELL HARRIMAN
ARCHER M. HUNTINGTON
ADRIAN ISELIN
ARTHUR CURTISS JAMES
WALTER B. JAMES
CHARLES LANIER
OGDEN MILLS
A. PERRY OSBORN
GEORGE D. PRATT
THEODORE ROOSEVELT
LEONARD C. SANFORD
JOHN B. TREVOR
FELIX M. WARBURG

JOHN F. HYLAN, MAYOR OF THE CITY OF NEW YORK
CHARLES L. CRAIG, COMPTROLLER OF THE CITY OF NEW YORK
FRANCIS D. GALLATIN, COMMISSIONER OF THE DEPARTMENT OF PARKS

GEORGE H. SHERWOOD, Executive Secretary

SCIENTIFIC STAFF

FREDERIC A. LUCAS, Sc.D., Director

Geology and Invertebrate Palæontology

EDMUND OTIS HOVEY, PH.D., Curator
CHESTER A. REEDS, PH.D., Associate Curator of Invertebrate Palæontology

Mineralogy

HERBERT P. WHITLOCK, C.E., Curator

GEORGE F. KUNZ, PH.D., Research Associate, Gems

Woods and Forestry

(Curatorship Vacant)

Lower Invertebrates

HENRY E. CRAMPTON, PH.D., Honorary Curator
ROY W. MINER, A.B., Associate Curator (In Charge)
WILLARD G. VAN NAME, PH.D., Assistant Curator

FRANK J. MYERS, Research Associate, Rotifera
A. L. TREADWELL, PH.D., Research Associate, Annulata

Entomology

FRANK E. LUTZ, PH.D., Curator
A. J. MUTCHLER, Assistant in Coleoptera
FRANK E. WATSON, B.S., Assistant in Lepidoptera
JOSEPH BEQUAERT, PH.D., Assistant in Congo Zoölogy

CHARLES W. LENG, B.S., Research Associate, Coleoptera
HERBERT F. SCHWARZ, A.M., Research Associate, Hymenoptera
WILLIAM M. WHEELER, PH.D., Research Associate, Social Insects

Ichthyology

BASHFORD DEAN, PH.D., Honorary Curator
JOHN T. NICHOLS, A.B., Associate Curator of Recent Fishes
F. W. GUDGER, PH.D., Associate in Ichthyology

Herpetology

G. K. NOBLE, A. M., Assistant Curator (In Charge)
KARL P. SCHMIDT, B.A., Assistant Curator

Ornithology

FRANK M. CHAPMAN, Sc.D., Curator
W. DEW. MILLER, Associate Curator
ROBERT CUSHMAN MURPHY, D.Sc., Associate Curator of Marine Birds
JAMES P. CHAPIN, A.M., Assistant Curator, African Birds
LUDLOW GRISCOM, M.A., Assistant Curator

Mammalogy

J. A. ALLEN, PH.D., Honorary Curator
ROY C. ANDREWS, A.M., Associate Curator of Mammals of the Eastern Hemisphere
H. E. ANTHONY, A.M., Associate Curator of Mammals of the Western Hemisphere
HERBERT LANG, Assistant Curator, African Mammals
CARL E. AKELEY, Associate in Mammalogy

Vertebrate Palæontology

HENRY FAIRFIELD OSBORN, LL.D., D.Sc., Honorary Curator
W. D. MATTHEW, PH.D., Curator
WALTER GRANGER, Associate Curator of Fossil Mammals
BARNUM BROWN, A.B., Associate Curator of Fossil Reptiles
WILLIAM K. GREGORY, PH.D., Associate in Palæontology

Comparative Anatomy

WILLIAM K. GREGORY, PH.D., Curator
S. H. CHUBB, Assistant in Osteology

J. HOWARD MCGREGOR, PH.D., Research Associate in Human Anatomy

Anthropology

CLARK WISSLER, PH.D., Curator
PLINY E. GODDARD, PH.D., Curator of Ethnology
ROBERT H. LOWIE, PH.D., Associate Curator of Ethnology
N. C. NELSON, M.L., Associate Curator of North American Archæology
HERBERT J. SPINDEN, PH.D., Associate Curator of Mexican and Central American Archæology
CHARLES W. MEAD, Assistant Curator of Peruvian Archæology
LOUIS R. SULLIVAN, A.M., Assistant Curator, Physical Anthropology

CLARENCE I. HAY, A.M., Research Associate in Mexican and Central American Archæology

Comparative Physiology

RALPH W. TOWER, PH.D., Curator

ALESSANDRO FABBRI, Research Associate, Physiology

Public Health

CHARLES-EDWARD AMORY WINSLOW, D.P.H., Curator

Public Education

GEORGE H. SHERWOOD, A.M., Curator
G. CLYDE FISHER, PH.D., Associate Curator
RUTH CROSBY NOBLE, B.A., Assistant Curator
GRACE FISHER RAMSEY, Assistant

Library and Publications

RALPH W. TOWER, PH.D., Curator
IDA RICHARDSON HOOD, A.B., Assistant Librarian

Preparation

LAURENCE VAIL COLEMAN, M.A., Chief

From a photograph supplied through the courtesy of Henry Fairfield Osborn

ENTRANCE TO VALLEY OF IAO, WEST MAUI, HAWAIIAN ISLANDS

Iao Valley is one of the places in the Hawaiian Islands famed for its beauty. Bordered by precipitous cliffs thousands of feet in height, which rise into mountains culminating in the peak Pau Kukui, 5788 feet above the sea, the islanders are wont to compare its scenery to that of the Yosemite Valley. Iao's cliffs, however, are covered with tropical verdure, which adds greatly to their beauty. A needle of rock more than 300 feet high rises abruptly from the floor of the valley within the amphitheater-like basin at its head, nearly five miles from the coast. The mountains are the remains of ancient, extinct volcanoes, which are so old that erosion has removed most of their external resemblance to their more recently active neighbors, such as the great Haleakala, which forms the eastern half of the same island. Wailuku, the chief town of the island, lies in the foreground at the entrance to the valley

NATURAL HISTORY

VOLUME XXI JULY–AUGUST, 1921 NUMBER 4

EXPERIENCES IN A VOLCANO OBSERVATORY*

BY

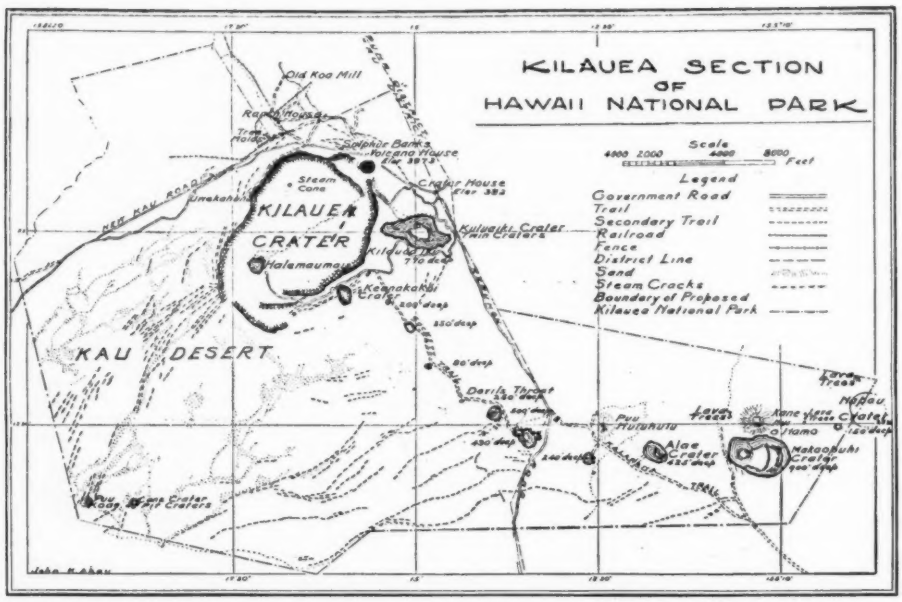
T. A. JAGGAR, JR.†

THIS is a story of volcano experience at first hand from one who dwells on the border of Kilauea crater. This living with a live lava pit has, moreover, a motive. Geology deals with the collecting of evidence for making out a case to argue before the august tribunal of Science, and that serene but relentless judge is becoming more learned and more critical as she adds centuries rather than years to her tenure of office. Physical science is no longer content that a few good stories of adventure and tales of heart-rending disaster form the subject matter of law books dealing with the treatment accorded by Mother Earth to the human denizens of her islands and harbors. These beings need help; they are building great cities, canals, docks, and traffic ways where only lazy cave men lived before. Property and persons require protection, and the news fresh from China that forty thousand people have lost their lives by earthquake is only a statistical item in a list of similar tragedies. Science demands an accounting, humanity audits the books, and geology must be something better than inspector or detective; it must be a barrister familiar with every phase of terrestrial vitality, knowing figures as well as facts, prepared to call as witnesses the typhoon, the tidal wave, and the volcano.

None of these is as bad as it is painted —least of all the volcano, popularly supposed the worst. Volcano insurance would be a safe risk for any underwriter. The damage is concentrated occasionally, but there are long periods of happy, sunlit days. When I first came to Hawaii twelve years ago, it was possible to frame a tentative schedule for Mauna Loa based on statistics, to state that an eruption would come before 1915; an eruption came in 1914. It was possible to predict that Kilauea and Mauna Loa would show some sympathy, not as tubes full of red-hot liquid, but as gas vents for an underground, glassy froth. Three times in the decade Mauna Loa, the monarch, has vomited great fiery geysers of molten, basaltic foam, and each time Kilauea, the vassal, has led the way with preliminary rising in its pit, which has spurted farther during the great crisis, and has collapsed dramatically at the end. The total period of a Mauna Loa cycle was expected to endure about nine years: 1907 was the year of the last culmination, with minor eruptions before and after; 1916, nine years later, marked the middle event of the recent great series of eruptions. The year 1912 brought the former period to a close, with much turbulent, fiery action; 1921, nine years later, appears to be bringing the present period to its end, and the turbulence in March was fiery enough to satisfy the most sceptical. Now all is low and smoky in the Kilauea pit. There will be recrudescence again and again for a year or more, then a sinking away, a dull year or two, and

* Published by permission of Charles F. Marvin, Chief, U. S. Weather Bureau, under authority of the Secretary of Agriculture. Illustrated with photographs by the author.

† Director, Hawaiian Volcano Observatory.



The lakes of foaming fiery lava within the crater of Kilauea form the most spectacular exhibit in the Hawaii National Park, if not in the world. The pit of fire, Halemaumau, is inside of the main crater, at the apex of a broad, flat, inner cone. Kilauea is a dome volcano 4,000 feet high, overridden by the lava slopes of Mauna Loa on the west, so that it seems but a spur of the greater, and perhaps younger, slag-heap mountain.

The Kilauea Park and the inner pit itself are both reached directly by automobile from Hilo, the second city of the Territory of Hawaii, and there are excellent hotel accommodations. The distance from Hilo is 30 miles. Within the park there are 15 miles of roads and about 20 miles of trails. As shown on the map, there are a dozen ancient pits within the area of the park, as well as cones, caverns and hot solfataras and a strange desert where lava flows have recently poured out of cracks.

The live pit of Halemaumau is easily accessible and not dangerous. Frequently one can walk to the actual edge of the splashing, fountaining lava lakes, the lava column rising and falling from year to year so that its most distinctive character is ceaseless change. At night the spectacle is full of marvelous color, and the region is a paradise for artists, photographers, and naturalists.

The several sections are under the control of the National Park Service of the Department of the Interior. The United States Weather Bureau maintains the Hawaiian Volcano Observatory, which stands on the brink of the greater crater within the Kilauea Park.

earthquake shocks fewer, but sometimes strong.

When one points to statistics, it is important to have statistics accurate, even if not precise, and to make the measures precise as soon as possible. This takes time and method, hence the founding of an observatory. Volcanoes are not clocks; they do not run on schedule; but Kilauea volcano and its neighbor have followed an accountable law during the last decade, whereas the great human drama which culminated in the eruption of 1914 appears to be rather unaccountable by the doctrines of economics and finance. Volcanoes are not nearly so dangerous as are the pent-up spirits of nations when these rend their restraints.

The Hawaiian Volcano Observatory, like most affairs of science, was the outgrowth of years of talk and planning, advice of engineers, disasters at Mont Pelée, Vesuvius, and Messina. Kilauea in the nineteenth century was casually studied by visitors; now it is steadily studied by resident men of science. We have learned of cycles small and great; of hot gases and their chemistry dominating the heat riddle; of pressures underground released by sun and moon; of a lava column far from simple, more solid and less hot underneath, more frothy and hotter on top; of earthquakes many and small when the lava is high, few and more alarming when the lava is low; of oxidations and dissolvings by air and water which make brand new, hot rock look old in a few days, and analyze the geologist's specimen before he has

time to collect it. We have found the ground tilting under our feet in a measure unheard of elsewhere; nay rather, much reported elsewhere, as in Japan during the great eruptions of the north and south islands in 1910 and 1914, but *only at active volcanoes*. Along with the tiltings came tremblings; the poised pendulums of the dark seismograph cellar, timed with good clocks, equipped with slender pens and with beams of light, and writing ceaselessly on creeping sheets so that the whole organism pulses with heartbeats like a thing of life, make record of all these motions. Minute to minute and decade to decade an attended instrument plant replaces the accidental report of the traveller of aforetime.[1]

Such a novelty of method can hardly fail to make discovery. For after all discovery is merely "uncovery" of what is always there but unrevealed. It has been the same story of new and unexpected revelations when we came to survey the glowing lava pools and blowing cones, and to measure the widths and depths of flows and lakes and their hardened margins. Now and then nature marches by leaps. In 1916 and 1919 there were red-letter—or red-lava—days, when in a few hours the column in the pit sank away four hundred feet and more, the ground shook, red-hot avalanches crashed inward; swirling, rushing cascades of fire tumbled into voids, and the red-brown dust boiled up in volutes. Again, while with some Harvard students I was surveying the tidal motion of the lava lakes, taking shots with transit from a tent every twenty minutes for a month, there suddenly burst up through cracks, in the night, a wonderful geyser of liquid lava a few paces behind us. It quietly welled up like an artesian well or an oil gusher, bright orange, dome-shaped, bubbling with burning hydrogen and carbon gas and sulphur, standing fifteen feet high and twenty feet across, and sending a torrent down the slope, which did not stop for three months. Just recently, at the March equinox in 1921, the pit was dull, with lava crusted and sluggish, fifty feet down, fourteen hundred feet across. In one night it lifted bodily lakes, islands, and craggy shores, all inside the pit, and at six o'clock in the morning it was flooding the outer slopes with lava streams which ran a mile; then the reaction due to release of pressure made vast cauldrons of the lakes, with fountains by hundreds, brown gushes of fume, fiery tornado whirlwinds, which threw twenty-pound blebs of live lava a hundred yards away, and the edges were built up into ramparts of black glass. The ground was strewn with clinker and spun glass—the blond "Pele's Hair" of the Hawaiian goddess; butterflies and moths were lured to their death by hundreds.

More virile adventure was offered by the Mauna Loa[2] eruptions: first some "queer" symptoms at Kilauea and a somewhat destructive earthquake; then —again at the equinox, September of 1919 —a sudden gush of fume and fire spume away up on the great flat mountain. Two days of quiet succeeded, but the pack mules were made ready. At midnight was seen a dull, distant glow, far below the first outbreak. Off at day-

[1]The Hawaiian Volcano Observatory is equipped with the following seismometric instruments rebuilt at the station in 1918 for the special needs of volcano research: two Bosch-Omori pendulums, high-speed registration of local earthquakes; one optically recording seismograph for distant earthquakes; one clinograph registering E-W tilting of the ground. A vertical component seismograph was in December, 1918, set up in experimental operation. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by wireless signal from the Pearl Harbor Naval Station. The chronometer is lent by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

[2]Mauna Loa, a vast dome 13,675 feet high, reached through forests of Hawaiian mahogany (koa) and tree fern, then up brilliantly colored lava slopes, has a summit crater 3 miles long by 1½ miles wide, with walls 700 feet high. Every five or ten years splendid spectales of lava eruption are staged on the mountain, sometimes from the lower flanks.

There are trails on the Kona side, and also from the southwest, but the usual and best route is with saddle mules from the Kilauea section to Puu Ulaula (9,800 feet), a ride of six hours. Here there is a fully equipped cottage with stables and water supply. From this point on the second day a four-hour ride takes the visitor to the summit crater, where there is water. A right of way within the park connects Kilauea with Mauna Loa, where eventually a road will be constructed. The views are glorious and the chasms, cones, and contorted lavas indescribably chaotic.

A VOLCANIC FOUNTAIN ON MAUNA LOA

A detailed view, October 25, 1919, obtained by climbing to the edge of the greatest erupting cup on Mauna Loa, the ground covered with red-hot cinder, the fountain shooting 200 feet above the froth pool at its base, and the nearest fragments falling 50 feet away. Gas is the impelling force, the jet coming from a narrower orifice below, churning and shredding the puddle of melt to bright red-hot fragments from six inches to four feet in diameter

light, we camped in upland meadows, and after two days of riding and hiking across fearful country, the Hawaiian "aa" or clinkery lava, we came to the great rift. Here fountains were flinging a light, brilliantly glowing pumice four hundred feet into the air from a crack line a half-mile long, building cones and flooding the country with lava flows that meandered within an incandescent flood plain for three miles, as far as we could see. We made bivouac and spent several nights, returning again and again, always finding new, golden, spouting cones and shifting vents. Over the fountains for thousands of feet rose a salmon-colored cloud, and at night a banner of flame below, reddish and yellow and green.

The flood beyond our view ran down through the forest, burned houses and crops and poured for six weeks into the ocean. Odd, unknown, deep-water fish were killed, tidal waves rose on the shores, and columns of steam shot up. The eruption was different from Kilauea in the frothiness, the intense gas inflation, and the enormous gas jets. The color, the lava, the composition of the gases, and the mechanism were essentially the same. The ejection was under high pressure. When this eruption came to an end, warned by what had happened in 1914 and 1916, I expected a sudden sinking at Kilauea. Kilauea had increased its outflows. On November 28 the lava in the pit sank *four hundred feet in an hour*, all the flowing stopped, and within four hours it was six hundred feet down.

The story of these critical adventures is what one expects of a volcano, but the observatory has other work to do. Volcanism is fundamentally an emission of gas. The substances most important are hydrogen, nitrogen, carbon, sulphur, and chlorine, and it is the compounding of these with oxygen in many proportions and in shifting reactions, locking up energy or releasing it, that makes the heat problem of the inside of the earth. Expulsion of gas is going on all the time at volcanic places, whereas expulsion of lava is a subordinate phenomenon. By convection lavas are worked over and over in the furnace, like scrap iron in a foundry. When there are numerous volcano observatories, we shall work out the tonnage of gas and the tonnage of rock produced. The ultimate goal of such stations is to determine the rate of expenditure of energy by the volcano and to find out just what work it is doing. When we know these things, we can tell whether the power is available for man to use and what relation the volcanic output bears to air, water, continents, mountains, earthquakes, and the so-called "crust." Only when a simplified motive is found can limited human powers do a specified piece of work. The simplified motive of the volcano observatory is to study gas.

This work is slow, uphill plodding, which can be done at Yellowstone Park or at Lassen Volcano in California, just as in Hawaii. The composition and reactions of these gases are changing; their effects on the rocks are almost unknown; their heat mechanism is very difficult; their radio-activity is important; their collection for study or spectroscopic observation has never been done properly or in any controlled manner. For all any body knows volcanism as gas-maker may be oozing forth everywhere. The great differences of underground temperature at Calumet and Hecla as contrasted with the Mother Lode in the Sierra Nevada may be dependent in some fashion on subterranean gases. The explanations of granite, of ore deposits, and of a hundred geological riddles hang on this gas problem. Even the laboratory handling of gas is still an infant science, and the field study of the atmosphere is hardly more than a half-century old. Hence it is not remarkable that the field study of the gases in the earth has hardly begun, and it will not be begun until we have more volcano observatories. Here is a subject which

obviously is not dependent on great eruptions for its investigation; we do not wait for someone to fire a cannon in order to study gunpowder. Every active volcano when quiet is a fascinating chemical laboratory with gases locked in its lavas, oozing through its fume holes, reacting with other gases and with air and water, and telling the story in cryptic language of what has been, what lies beneath, and what is to come. When the outburst does come, gas chemistry is unquestionably dominant, and every resource of engineering and physical science should be brought to bear on its analysis. There has never been a volcanic eruption which was prepared for with adequate men and apparatus gathered on the spot. Some day the paroxysmal gases of a great eruption will be competently collected or observed with as much *sang froid* as we now observe a transit of Venus.

The gases come from a dough or paste compressed inside the outer shell of the globe. This paste, which geologists speak of as magma, is rigid; when it foams up cracks, we call it a lava flow. The chemistry of that magma is more than half gas chemistry. Oxygen constitutes nearly 50 per cent. by weight of the solid rock we walk upon, and there is as much oxygen in the upper six feet of the earth's surface rock as in the whole atmosphere lying above. The volcanic gases are conceived as dissolved in the compressed paste, and when the pressure is relieved, the gases heat the paste and escape as bubbles. Volcanism is concerned with this paste, its pressures, temperatures, and bubbles. Geologists have studied with microscopes the minerals of the hardened rock, and chemists have produced analyses from such rock which they describe as "composition of the magma," without any knowledge of what gases and salts were long ago removed from the real magma, a very different substance from the skeleton which hardened and dripped with water for centuries. At a volcano like Kilauea one may study surface forms of the hot paste itself, fast oxidizing and losing its gases to be sure, but still subject to experiment before it is wholly transformed.

The active volcanoes of the world offer marvels of discovery to come from boring, gas analysis, water analysis, magma experiments in the field, routine records in relation to time, local studies of ground motions, careful analytical and synthetical work dealing with nature's complex solutions and nature's complex reductions and oxidations. This work cannot be done with transported specimens. The transported specimens are washed-out skeletons. It cannot be done by expeditions, they see too little. The need is for laboratories in the actual volcanic field and for workers with modern apparatus, living there, working there, making their own social group, modifying their experiments in accordance with daily inspiration at all seasons from nature's own demonstration of what ores she is concentrating. She is working with dilute solutions through centuries. These must be reckoned with. She is working *per saltum* magically in a single night. The analyst must be there *on that night.* He will learn more in an hour than he ever dreamt of in years at the university. He may wait in the field a year, soaking in impressions and making preparations, just to be ready for that hour with his spectrograph or electroscope. Meanwhile there is never an idle moment, for the whole landscape is alive, and other problems crowd so fast on the heels of time that his only difficulty will be to keep up. Such is life at a volcano observatory.

A SERIES OF PICTURES OF UNUSUAL INTEREST, SHOWING THE HAWAIIAN VOLCANOES, KILAUEA AND MAUNA LOA, IN THEIR ERUPTIVE PHASES

BY

T. A. JAGGAR, JR.

Director of the Hawaiian Volcano Observatory

CLOSE VIEW OF A NEWLY FORMED CONE

On March 30, 1917, this cone was formed in three hours by lava spatter at the edge of a fountaining lake of melt. The picture shows it at night, the gas explosions flinging out the slopping incandescent stuff, and in the midst a pale flame playing. The camera was only thirty feet from it

HALEMAUMAU, THE LAVA PIT OF KILAUEA

Photograph taken in January, 1918, just before the pit overflowed and destroyed the road terminus. A confusion of towering crags had been lifted amid the boiling lakes, and all of this is the live lava column, all rising together several feet a day. The tipped scarp on the right shows how the crags are built with tilted shores, the paste moving irregularly according to the gas pressure below and the distribution of weight above

A GUSH OF LAVA

Gas is the dominant agent of volcanism. November 2, 1918, there came a sharp earthquake and a gush of lava up through cracks back of the rim of the Kilauea lava pit, making a craterlet right alongside of the horse corral and rest house, and finally burying both under floods of lava

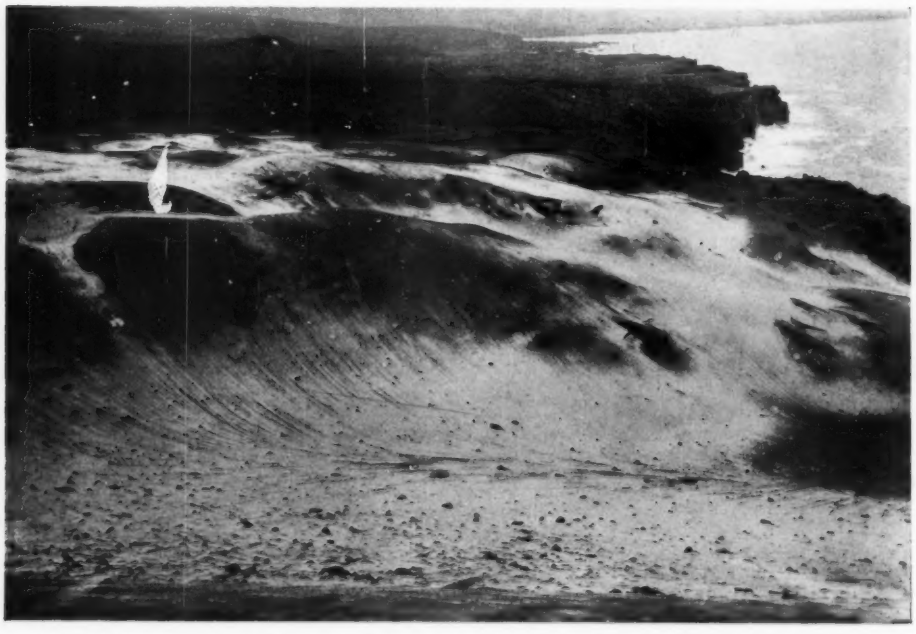
A Surveying Station at Halemaumau.—The weekly surveys at the pit are made from concrete trig stations. On February 21, 1919, the lava had come up level with the edge of the pit, and the ground started smoking and depositing sulphur around this level, circular platform with its central post

A Surveying Station Displaced by Rising Lava.—On February 28, 1919, this trig station had been lifted bodily, tipped back 40° and fractured. A neighboring station had pushed back still farther and fallen over, buried under its own débris. Both were on the edge of the pit on old rock. All of this started on February 25, when a sudden swelling of the stiff paste inside the pit mashed the rim back into a pressure ridge which has been a landmark 20 feet high ever since. In seven hours, the rim of solid rock was tilted back 10°, then came a gushing of liquid lava up the cracks and floods of overflow

One of the Gushers of Molten Lava Which Ended the Sudden Part of the Swelling of February 25, 1919.—The humping of the rim began in the forenoon, and at 5.30 P. M. three of these fountains were feeding outrushing flows. This fountain was just inside the rim of the pit and lasted in this condition for an hour, then gradually subsided with gas sputtering

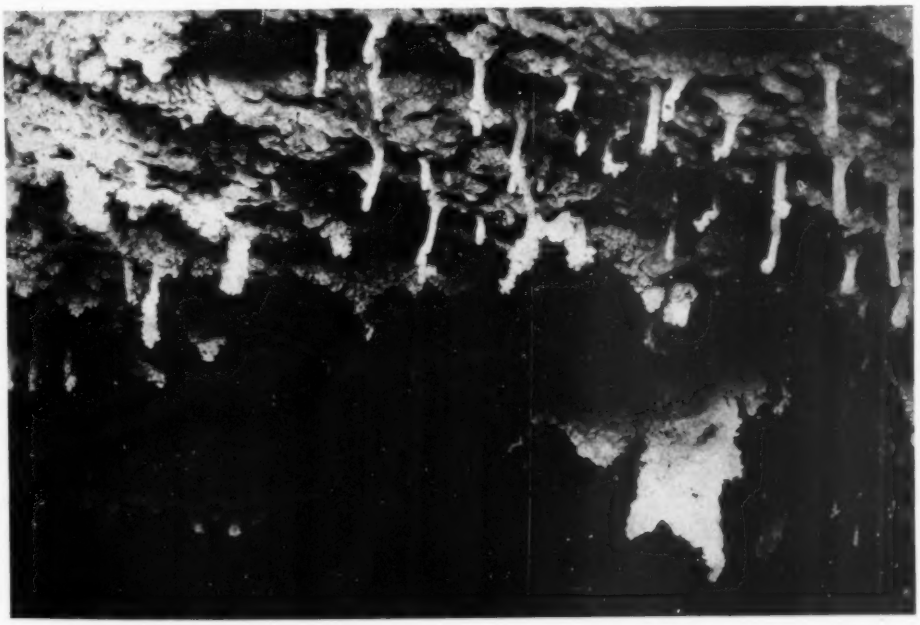
Liquid Lava Cascading from the Lake.—The lava pit is no less spectacular when it is going down. Great voids form at the sides of the liquid lakes, because the froth lowers some of the wells which honeycomb the hard lava column. Up other wells the liquid is rising, but the two sets lose step, for the lava lakes are shallow and variously blocked by their own shoals. Over these shoals pour cascades, and this picture of June 9, 1919, shows a whole lake tumbling perpetually into a hole at one side which it never fills. This fall continued for ten days

A Stream of Liquid Lava, Alika Flow, Mauna Loa.—From the first day of the Mauna Loa eruption, the flood ran down through the forest and burned houses and ava crops and cord wood, and imprisoned cattle in the clump of trees seen in the background of this picture (October 6, 1919). Here, as in the lava pit of Kilauea, the liquid lava is shallow and subordinate, the vast slow-moving field of clinkery lava, red-hot beneath, is the main glowing product. The torrent silently rushed by, carrying huge lava "snowballs" down its middle every few seconds



Sand Heaps over Lava Where the Mauna Loa Flow Entered the Sea, October 28, 1919.—The hot flood poured for six weeks into the ocean, columns of steam and sand shot up, odd, unknown, deep-water fish were killed, and some people were washed out to sea by the tidal waves. The white coating on the sand is sea salt

Smooth Lava Flow in Motion in the Kau Desert to the South of Kilauea Crater, June 25, 1920.—It is flowing over ancient clinker flows mantled with dune sands. These Kilauea flows followed after the Mauna Loa eruption and lasted eight months, building an immense lava heap along a fracture in the flank of the mountain



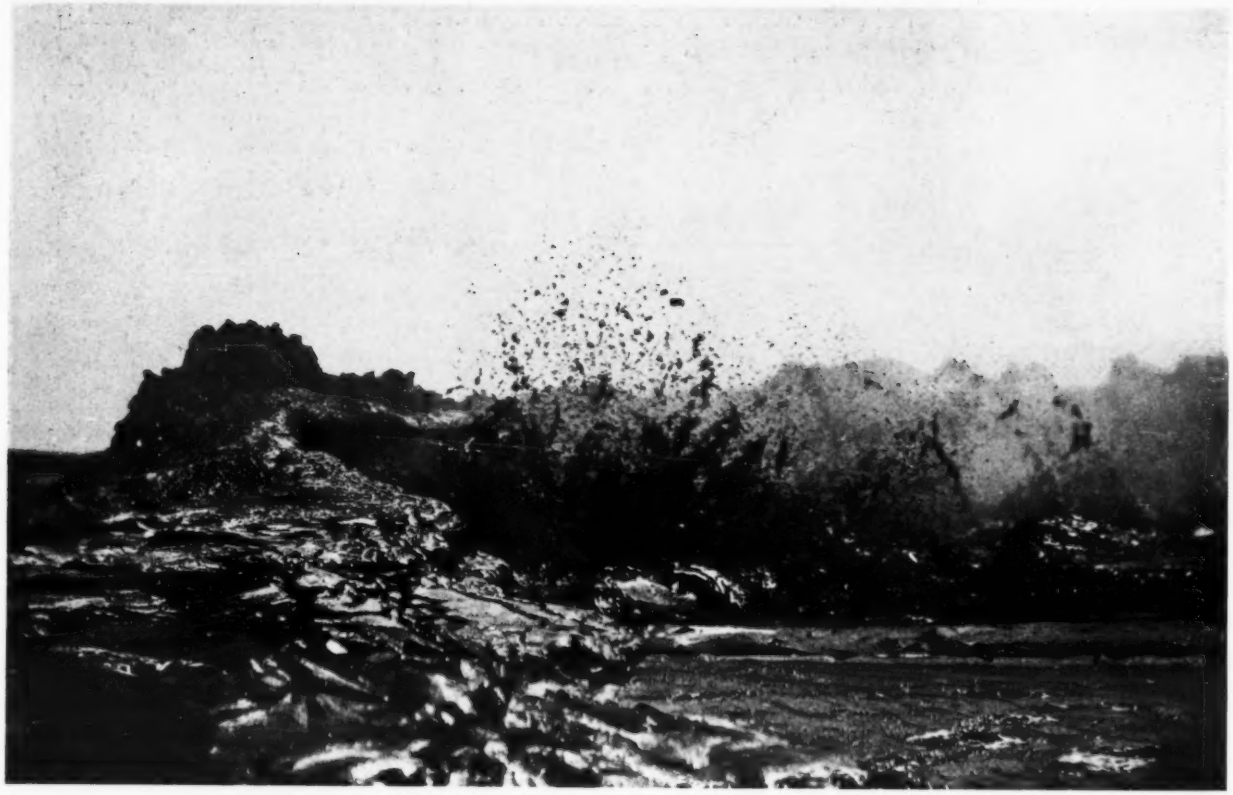
Lava Cavern, with Sulphate Stalactites.—In old caverns dating from 1823, in the Kilauea desert lands, sulphate stalactites were found June 25, 1920. Similar but more soluble sulphates were deposited by hundreds of pounds in the hot caverns of the present eruption. The material included alum, Epsom salts, iron sulphate, Glauber salt and lime sulphate. Dripping water made the deposit, and rain water later washed much of it down into the mountain

GLASSY BASALT FORMATIONS

This eruption through cones built up heaps of glassy basalt outside of Halemaumau pit but inside of the greater crater. On February 9, 1921, the lower of two rift cones was an open horseshoe with a bubbling pool inside and a rivulet of the molten matter rushing away

AN "ARTESIAN" DOME

The same location had a renewed and very voluminous outpouring at the equinox, March 20, 1921, and this remarkable photograph is an instantaneous picture of the orange-colored "artesian" dome over the same vent as is shown in the preceding picture. The photograph was taken by running up to the fountain on the windward side with the camera held against the photographer's forehead. Note the pure curve of the mass welling up and the network of expanding bubbles on its surface



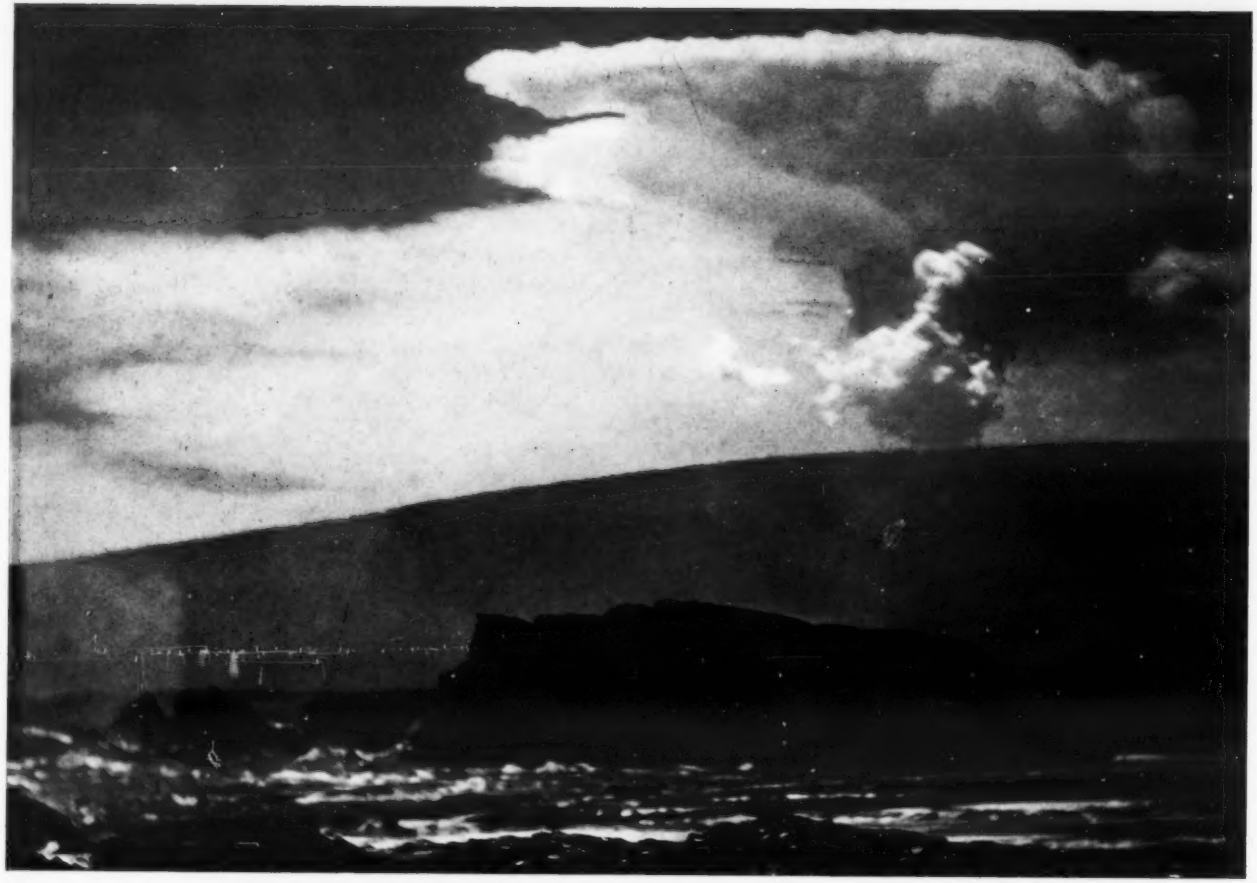
352

SPATTER RAMPARTS AT EDGE OF LAVA LAKE

March 19, 1921, was a day of excitement at Kilauea. Flows were running over on three sides and guards had to be established to keep tourists from going where they would be surrounded by lava flows. The arms of the lava lake, as shown here, resolved themselves into fiery cauldrons with cascades from the rest of the pit rushing in. The edge was built up into spatter ramparts fifteen feet high. Later the uprush of hot gases made tornado whirls

AN EVENING VIEW

Same scene as shown on page 352. In the four days intervening between the taking of the preceding photograph and the magnificent scene here reproduced, the overhanging ramparts of black glass had been built still higher. The lake of boiling lava is seen to be incandescent over its entire surface. The light from it was sufficient to bring out the opposing rim in the photograph

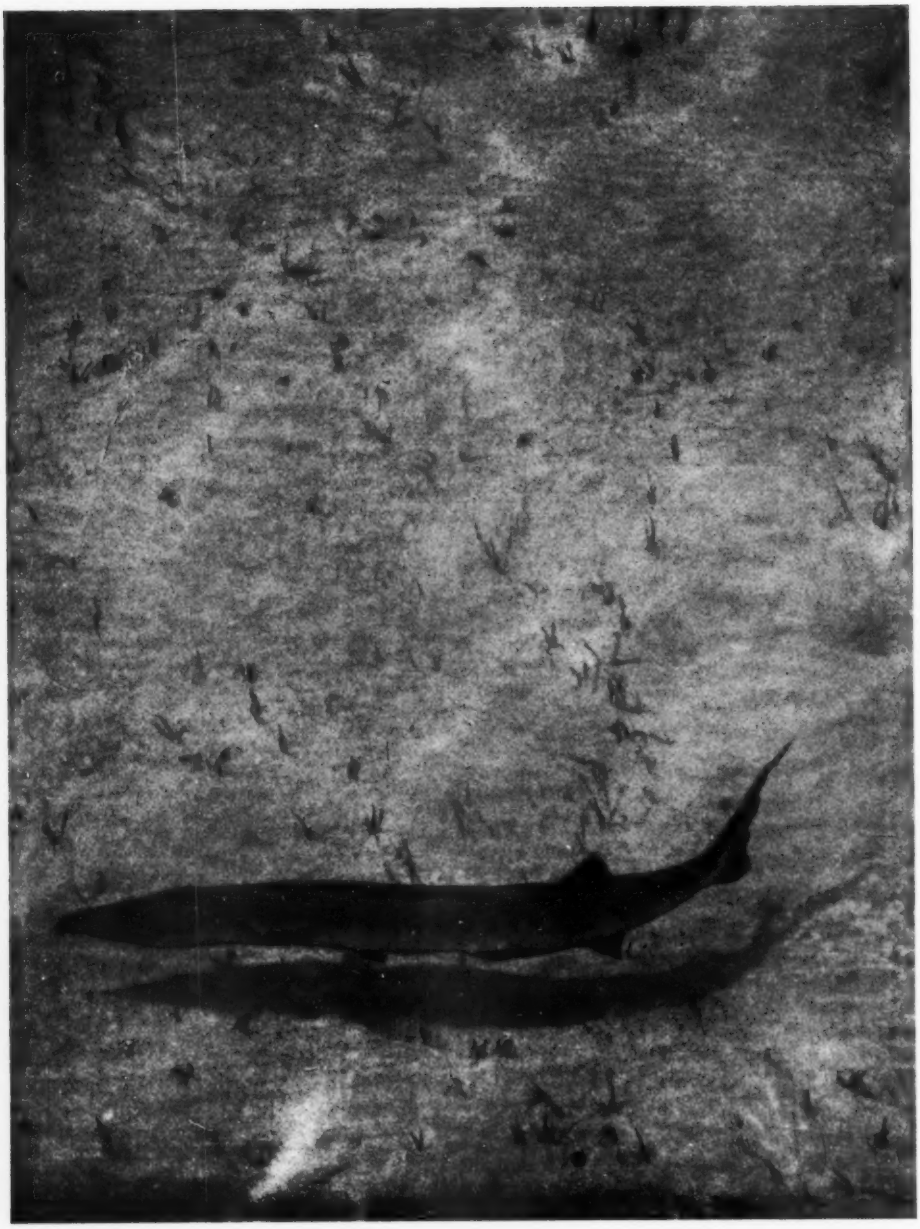


CUMULUS OVER SUMMIT OF MAUNA LOA

A sympathetic gush of hot vapor or some such phenomenon produced a wonderful cumulus over the summit of Mauna Loa on the afternoon of March 19, 1921, while the Kilauea eruption was at its height. In the foreground of this photograph is shown the Kilauea lava lake and the island rising above it. The lakes and crags had come up 50 feet in one night

STALACTITE FORMATIONS

A glowing oven formed after the lava had subsided, April 4, 1921. The stalactites are made of a glass due to secondary melting by gases. The stalactites are from two to three feet long. In the night a banner of flame, too faint to photograph, may be seen. Negative made with deep red filter



A BARRACUDA SWIMMING EIGHT FEET BENEATH THE SURFACE

From the Miami Aquarium Association we have this very remarkable snap shot of a great barracuda (*Sphyraena barracuda*) swimming in the clear water off the west coast of Andros Island. The fish is over a white sand bottom, eight feet below the unruffled surface of the warm, shallow sea, which stretches for miles in every direction and is technically known as the Great Bahama Bank. This fish is more feared by the natives than are sharks, though, as is usual in such cases, stories of its attacking man are vague and difficult to corroborate. It reaches a very large size, there being an unauthenticated report of an individual from the Bahamas, more than ten feet long, but to date no really large one has ever been tested with a steel tape. A barracuda measuring more than five feet has been taken on rod and reel at Long Key

THE MIAMI AQUARIUM*

BY

JOHN TREADWELL NICHOLS†

THE recent erection of a modern, well-equipped aquarium at Miami, Florida, is a matter for congratulation to those who are interested in furthering knowledge of the life of warm seas. The location is a preëminently appropriate one for such an aquarium. The Gulf Stream, sweeping close to the east coast of Florida at this point, gives a decidedly tropical character to the marine life of the neighborhood. At the same time it insures an accessible supply of pure sea water for the tanks of the aquarium, without which it is impossible to keep many of the more delicate fishes and other animals of the tropics for exhibition or for study.

Fishes which wander at the surface of tropical seas far from land are of much the same sort in all oceans; indeed, various of such species are of cosmopolitan distribution, as, for instance, some of the flying fishes. Wherever the trade winds blow, now faint, now strong, under the fleecy cumulus clouds by day and the low, bright stars by night, one may occasionally meet small, wandering schools of the fish called dolphin, preying on flying fishes. This is a graceful, slender species reaching a length of six feet. It may well be the swiftest fish that swims, and its colors at once the richest, most brilliant, and most delicate, playing across its sides like the fleeting shadows of clouds. No less widely distributed is the oceanic bonito, a thickset, rich-meated mackerel, with dark, lengthwise stripes on its flanks. Such widely distributed wanderers are but thinly scattered over the greater part of their range, and concentrated at certain favorable points in the world currents, as the Gulf Stream. The little fishing boats which one sees from Miami beach, bobbing about in the sunlight off shore, where the narrow, coastal shallows give place to the deep blue of the Stream, meet these nomads of the sea, as also the long, slender kingfish—relative of the Spanish mackerel—the big sailfish and spearfish—related to the swordfish—the albacore, bonito, and others. In the afternoon the day's catch is landed at the water front in the center of town. As many sportsmen have their most interesting fishes mounted as trophies, it will repay a student of these big, offshore forms to pay frequent visits to the local taxidermist.

About the coral reefs of warm seas, fishes are found the colors of which are remarkably beautiful and brilliant. A fine collection of such species is one of the features of the exhibitions at the New York Aquarium. The remoteness of New York, however, from tropical waters entails loss in transportation and loss through change of climate and other conditions demanding adaptation on the part of the fish. Because the Miami Aquarium is close to the waters where these fish must of necessity be captured, it contains many striking forms not to be found in aquariums located at a greater distance. For instance, the rock beauty is shown at Miami. Technically this fish is *Holacanthus tricolor*, of the angel fish order. Its colors are masses of contrasting black, and yellow and orange, and this was one of the species chosen to illustrate a discussion on high-colored tropical fishes published by the writer several years ago in the AMERICAN MUSEUM JOURNAL.[1] It is represented in the colored plate accompanying that article. In most of the broad area from Bermuda to Brazil inhabited by the West Indian fish fauna, the rock beauty is an uncommon fish. In the Bahamas,

[1] "The Problem of Bright-Colored Fishes" by John Treadwell Nichols. THE AMERICAN MUSEUM JOURNAL Vol. XVI, pp. 506-511.

*The illustrations used in this article have been supplied with one exception, by Mr. John Oliver La Gorce

†Associate Curator of Recent Fishes, American Museum

on the other hand, it is common, and is there known as the Spanish angel fish. It seems probable that the New York Aquarium by coöperation with its sister institution in the south, the Miami Aquarium, will now obtain this and other desirable species, which it has previously been unable to show to the public of our metropolis. A unique advantage which the Miami Aquarium will always hold for the student of warm-water fishes is its proximity to the grounds where they may be studied in their natural environment. Details of the habits of fish are only to be worked out in an aquarium, yet they can be properly weighed and coördinated only when one sees the fish in its environment, securing its natural food, avoiding its natural enemies, and living its natural life.

When the wind has been favorable for several days the surface drift from offshore is driven into Biscayne Bay to the very doors of the aquarium. It brings young flying fish in their interesting developmental stages and other species, many of which hide in the masses of floating yellow sargassum, or gulfweed.

Using Miami as a base one may cruise southward for material among sheltered channels, keys, and mangrove-bordered lagoons to the sandy shores of Cape Sable and the shallows of the Bay of Florida, all wonderfully rich in marine life. The varied coral reefs of the Bahama Islands, whose fauna is less well known, is within striking distance.

It will be seen that as regards assembling and caring for material, the location of this new aquarium is a favorable one. Its situation on the mainland of Florida and consequent accessibility to the centers of population and to the great scientific institutions of the north, should prove equally advantageous. Each winter a great number of people from all parts of the United States visit Miami. Many are sportsmen, interested in fish and fishing, or yachtsmen, perhaps, on their way to cruise among the keys, and a majority are on vacation, with leisure to ponder on the wonders of the ocean so near at hand. That this public is greatly interested in the life of the sea is evidenced by the large attendance at the aquarium, which thus has an unusual opportunity to do important educational work. At the same time it is close enough at hand to be a convenient field station for the scientific investigator, whose time is often limited. Proximity is an important matter for, at the present day, isolation makes effective research very difficult.

Some of the interesting problems in fishes which the Miami Aquarium will help to solve are local in nature. In spite of the labors of many students, the fishes of Forida, their seasons and migrations, have never been reported upon adequately. We know still less of the rich ichthyofauna of the Bahama Islands, where doubtless species of fishes as yet unknown to science will be found lurking among the intricacies of the corals and the waving sea plumes. No one has as yet determined the spawning grounds and developmental stages of so well-known a game fish as the tarpon. Tarpon have recently been taken with ripe spawn, and the mature egg of this great fish, which is known to reach sometimes a length of 8 feet and a weight of more than 300 pounds, is only $\frac{3}{4}$ mm. or less in diameter! It ought to be possible to hatch the eggs in the laboratory.

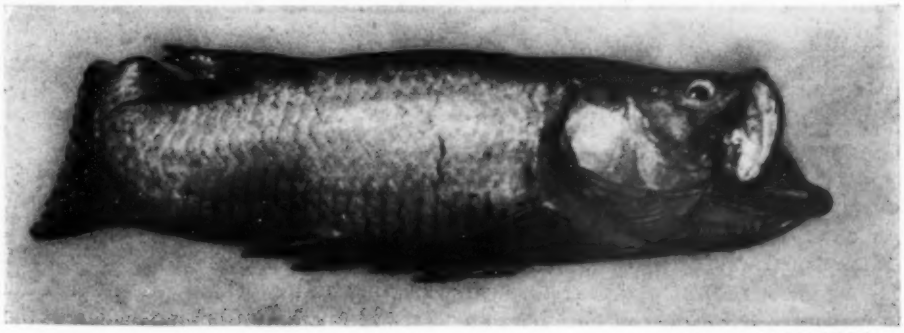
Other problems of warm-sea life, however, are world-wide in their bearing, and it is hoped that this new institution will not limit its scope to any local boundaries but will look far out upon the great, sunny ocean which encircles the world, past the Bahamas, the Antilles, and the Sargasso Sea to the coasts of Africa, Malaysia, and the myriad islands of the Pacific. The Gulf Stream itself, so close at hand, is the product of world winds and world currents. The trade

winds of the Atlantic which cause the surface water to drift ever westward against the American continent. Thence it escapes to the north through the narrow passage between Florida and the Bahama Islands. A similarity in the warm-water fishes of the Indian and the Atlantic oceans is perhaps traceable to warm currents from the Indian Ocean finding their way westward past the Cape of Good Hope, which extends south only to about the equivalent latitude of Cape Hatteras. There is, to be sure, a cold current from the stormy seas to the southwest which crosses toward southwest Africa, and which must form some barrier to the transfusion of warm-sea life, even though an imperfect one.

The fishes of Florida are known, in the main, from many trips and cruises of longer or shorter duration which have been made in the waters of the state by northern ichthyologists. With the establishment of the Miami Aquarium we have a station whence a watch will be kept on these sunny seas the year round, day in and day out. Interesting things which have previously been missed or overlooked should now be brought to light. Many of the ocean's myriad secrets remain remote and inaccessible through the years. Then by some chance the veil is lifted, making some critical observation possible. If there be no one there to see, a rare chance is lost, for the same combination of circumstances, presenting a similar opportunity, will not occur again for a long, long time.

Mr. Mowbray, director of the Miami Aquarium, had not been on the ground long when several great tuna were taken in nearby waters which he immediately recognized as representing a species never before examined and described by naturalists. The tips of their back and anal fins were greatly prolonged in narrow, band-shaped points, a condition approached but not equalled by a species known from far-away Japan. Save to one familiar with the almost inexhaustible possibilities of the sea, it would have seemed scarcely credible that such a fish should have inhabited the coastal waters of the United States without being discovered long ago. Indeed, this may have been a chance wandering school from some distant part of the ocean little known to students of fishes.

When the writer was in Miami, the director of the aquarium just chanced to gain possession of the mounted skin of a very peculiar and interesting individual of the tarpon, which he permitted us to photograph. It was a small example, only about three feet long, and entirely lacked the extreme hind end of the body, which should have carried the forked tail fin, a tarpon's chief organ of propulsion through the



Courtesy of W. B. Nichols

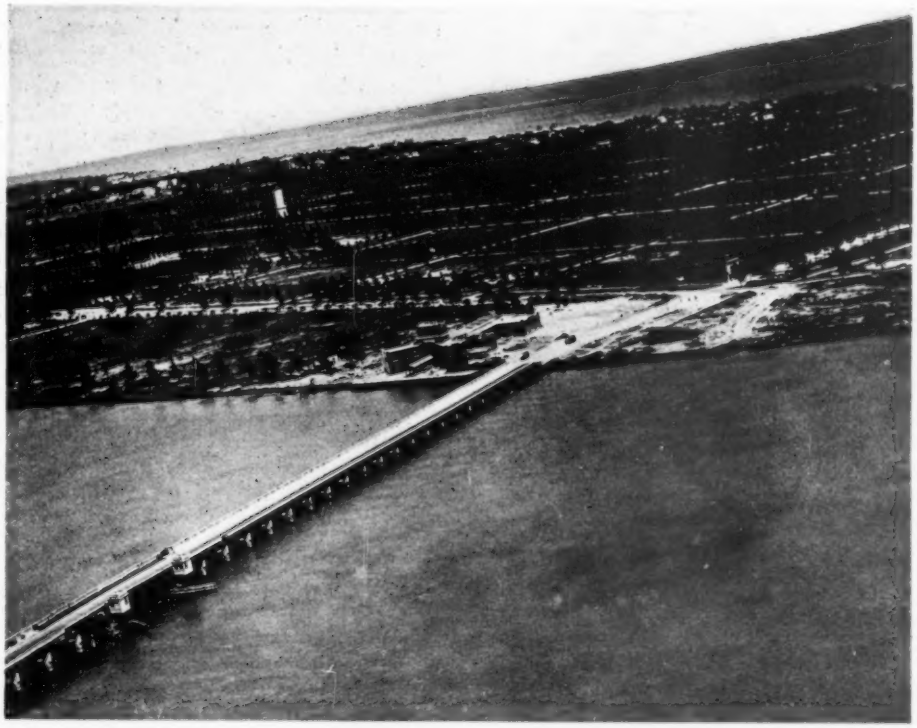
A tarpon that lacked the extreme hind end of the body. The anal in this specimen projected backward as much as downward and doubtless served as a fairly efficient organ of propulsion in place of the missing forked tail fin

water. The finless stump of a tail was turned upward so that its anal, the fin situated posteriorly on the mid-line of the lower surface, projected backward as much as downward. With the anal in such a position it had doubtless been possible for the fish in life to make fair headway by using that fin in place of the missing caudal. The interesting thing about this tarpon is that in overcoming its physical defects it paralleled the evolution of the fish's tail. The tail fins of modern fishes, though now placed symmetrically in the mid-line of the body, are ventral in relation to the notochord, which on dissection is found to turn upward in the tail region. The unsymmetrical tail fin, longer above, of primitive fishes, sharks and certain ganoids, represents a stage in the attainment of a symmetrical tail, the most efficient propeller.

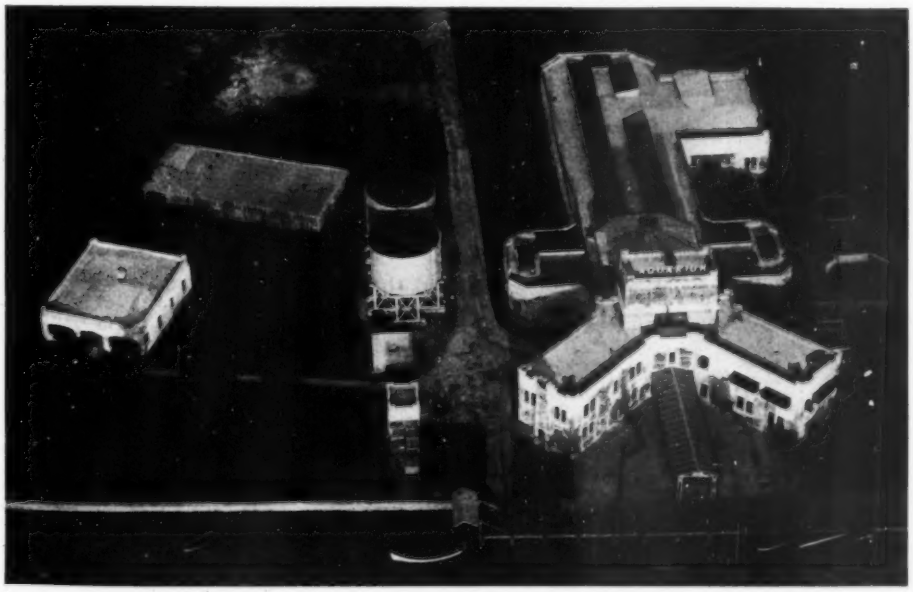
For an outline of the scope, equipment, and personnel of the Miami Aquarium Association, the reader is referred to an article, entitled "Treasure-House of the Gulf Stream," by John Oliver La Gorce, secretary and treasurer of the association, in the January, 1921, number of the *National Geographic Magazine*. Mr. La Gorce is a genuine lover of the ocean, and appreciates keenly not only its grandeur, mystery, and charm, but the economic and philosophic possibilities of a better knowledge of the infinite and varied life it contains. As associate editor of the *National Geographic Magazine* he has been in close touch with the broad educational work that is being done by the National Geographic Society of Washington, D. C., and he sees wide opportunities for educational work by the Miami Aquarium.

We are told that the president of the Miami Aquarium Association, Mr. James Asbury Allison, was prompted through a great interest in sport fishing to make available a laboratory where investigations might be carried on concerning the food value of warm-sea fish, and thus to enlarge the food supply of the country.

Not only will the aquarium seek information of this character through scientific study, but, having ascertained the facts, it will place them at the disposal of the public in popular, understandable form. Mr. Carl G. Fisher, vice president of the association, is identified with real estate improvements on a large scale in the city of Miami. It has been the aim of these gentlemen to establish an aquarium, equipped with the best laboratory facilities, which shall take second place, as a center of interest and of research, neither to the aquarium at Naples nor to the Museum of Oceanography at Monaco. No expense has been spared in erecting a first-class plant. The plan is to make it self-supporting as regards operating expenses and therefore an admission fee is charged. If this plan, which is perhaps somewhat experimental, proves successful, those features of the aquarium's work which meet with popular support will be enlarged and developed. Stagnation, which might creep into an institution that is not situated in a world center and that is at the same time entirely dependent on endowment, will thus be effectually barred. As director, the services of Mr. Louis L. Mowbray have been secured. Mr. Mowbray built and had charge of the aquarium at Bermuda, and later was associated for a number of years with the work of the New York Aquarium. He has had charge of the installation of the complicated tanks and interior equipment of the Miami Aquarium, obtaining and caring for the fishes shown there, already numbered in the thousands. No one has a better field knowledge of the fishes which live about these keys and islands than he, or has been more successful in locating and capturing the rarer kinds. It will, perhaps, be remembered that not long ago he presented the American Museum of Natural History with a large and valuable collection of marine



The Miami Aquarium, located at Miami Beach, Florida, was opened to the public on January 1, 1921. It is erected on the eastern terminus of the Causeway spanning Biscayne Bay



A picture, taken from an aëroplane, of the Miami Aquarium

fishes from Bermuda and from Turks Islands in the Bahamas, the rarer and more interesting specimens preserved from several years' cruising, observation, and collecting.

The new aquarium is located at Miami Beach, at the end of the long causeway which crosses Biscayne Bay from the city proper and not far from where the main ship channel opens from bay to sea. Its latitude and longitude are 25° 46′ north, 80° 7′ west. Its exhibition tanks are arranged along corridors in the general form of a Maltese cross with a central rotunda, about fifty tanks each with a visible area of 4x6 feet.

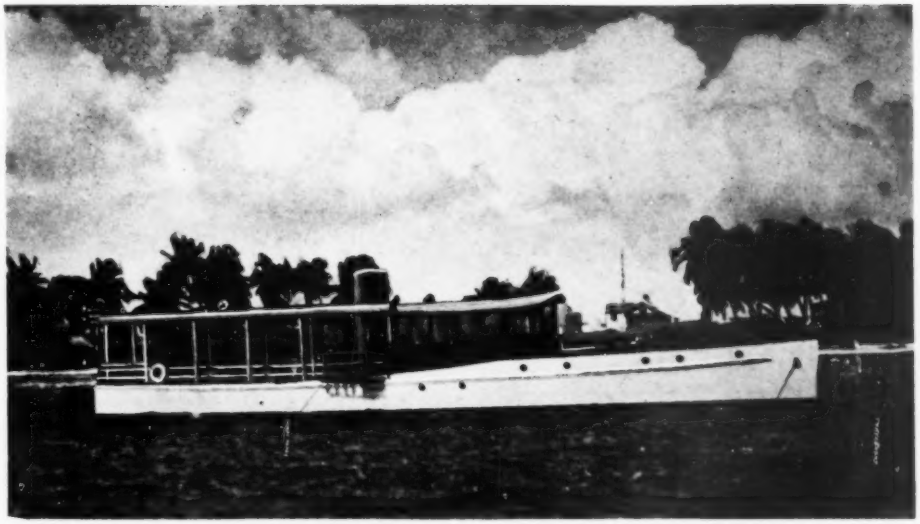
As has been remarked, Miami is very favorably situated for obtaining an exhibition collection of the highly colored fishes found about tropical reefs and channels. These are for the most part taken in fish traps. Through the courtesy of the Miami Aquarium Association and Mr. Mowbray, the writer recently made a trip on the collecting boat "Allisoni," especially designed and equipped for gathering living material. Our destination lay some miles to the southward where narrow, deep channels of clear water ran among shallows and among dense growths of green mangroves so characteristic of south Florida. Fish traps were lowered at especially favorable points, at times in pools where the fishes which it was desired to take could be seen swimming in the limpid water. The common blue angel fish of this part of Florida is *Angelichthys isabelita*, the same species that occurs in Bermuda. The aquarium's collections also contain the more highly colored *Angelichthys ciliaris*, which is common in the Bahamas, for instance among the "sea gardens" at Nassau. Both forms occur at Key West.

A tropical fish fauna is remarkable for the great variety of closely related species which it comprises. Lacking seasonal changes, these warm seas have presented practically permanent conditions for an infinity of time. This has made possible a very delicate adjustment of the fishes to their habitat, and balance between different forms whose habits, though superficially identical, doubtless differ the one from the other in slight but important details. We have here a fascinating subject for investigation, which can be carried on to advantage in the aquarium's laboratories and in the adjacent waters. The investigation should throw light on the laws governing the formation of species and those of marine life.

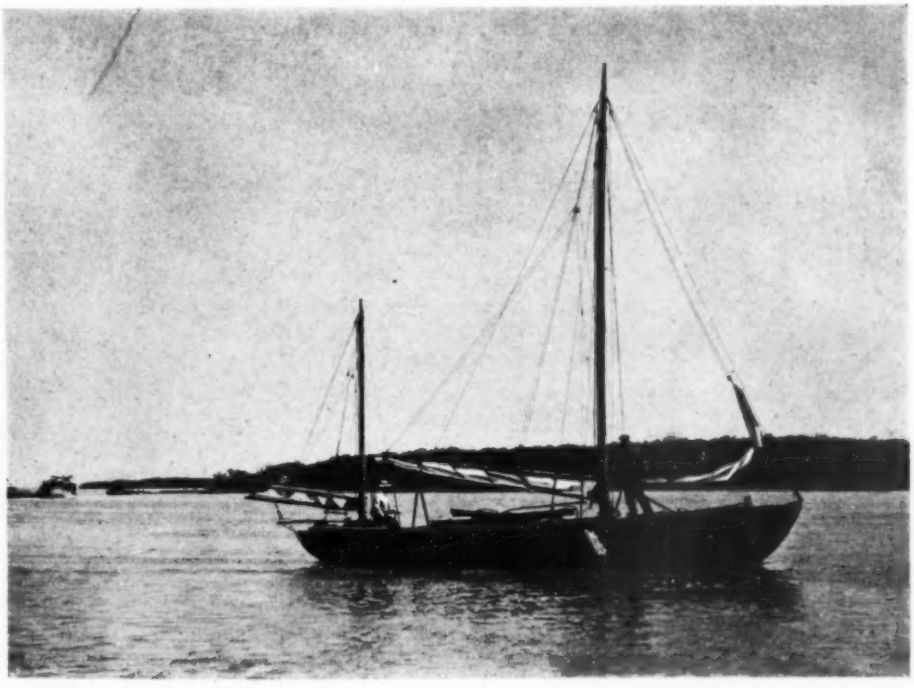
A considerable knowledge of the habits of fish is necessary to trap them successfully. One must first know where to look for them. To recognize the different species at large in the water is surprisingly easy for a trained eye, but Mr. Mowbray tells us that in some places where a desirable fish occurs and is even abundant, it is useless to attempt to capture it because it will not enter the traps. Elsewhere the same kind may be caught readily enough.

This collecting trip was a most enjoyable affair. A considerable number of the exquisitely blue parrot fish, *Scarus cæruleus*, were obtained. Where we lay at anchor our only competitors in fishing were birds, namely several royal terns, suggestive of the tropic birds of more remote seas. One passed us, closely pursued by a man-of-war hawk, giving an exhibition of speed and adroitness in the air. Once a big loggerhead turtle passed the anchorage, slowly stemming the tide and coming up at intervals to breathe. There was a fine breeze for the return over sunny stretches of water with a well full of fish; we had all the wind we wished to carry full sail to.

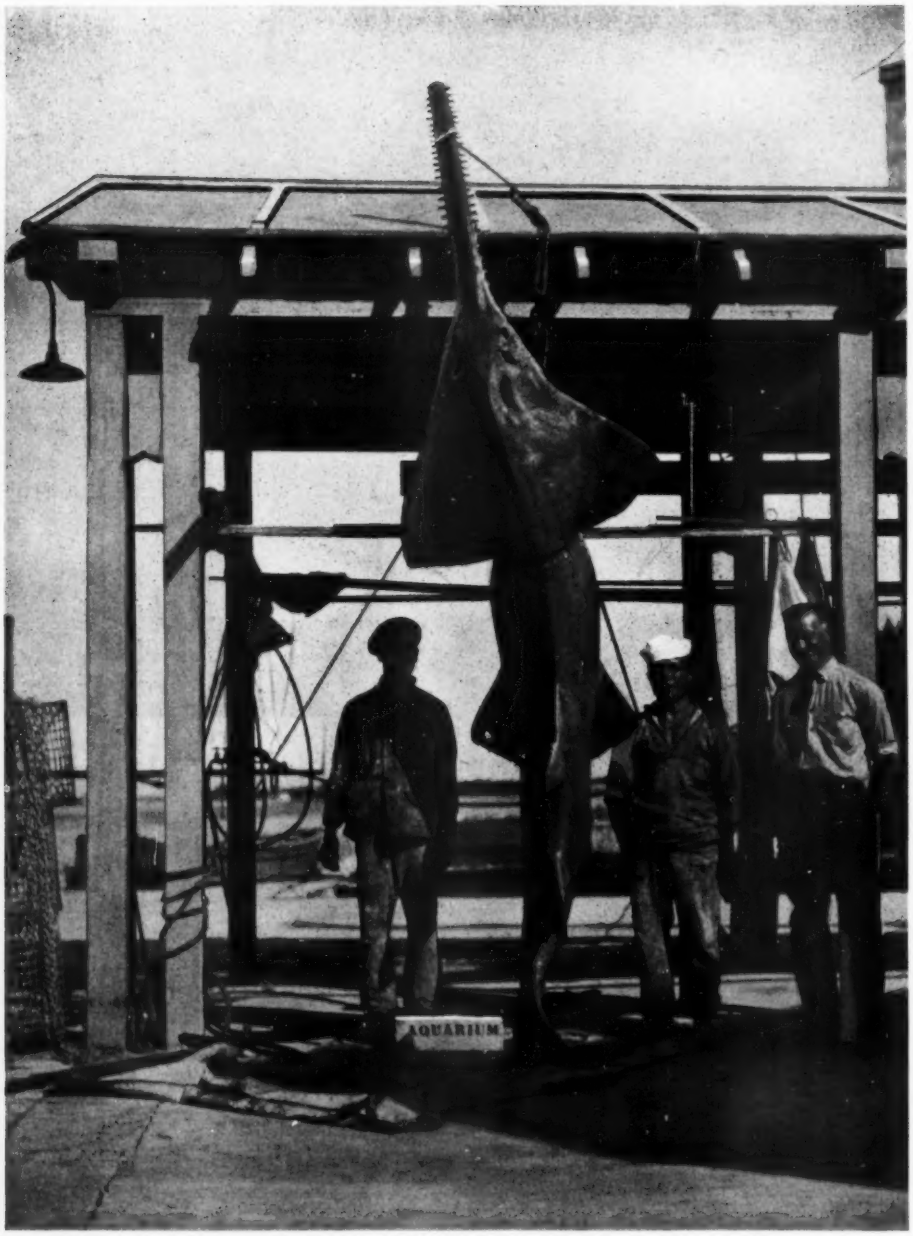
The center of our craft was, of course, walled off to form a well into which fresh sea water could freely penetrate from the outside, and here the catch was kept with minimum danger of loss by death while it was being brought home. Incidentally, the very peculiar motion which the "Allisoni" had when under way in a breeze may have been caused



"L'Apache," the yacht of the President of the Miami Aquarium, Mr. James Asbury Allison, which joins forces with the collecting boat in quest of fishes. The yacht is 74 feet by 12 feet, drawing 3 feet, 6 inches, and is provided with two 150 H. P. gas engines. When "L'Apache" is in port, she may usually be found alongside the Aquarium dock



The specially constructed collecting boat "Allisoni" 45 feet in length and provided with an auxiliary motor, has a large well for bringing live fishes back to the Miami Aquarium from distant reefs and channels. It was in this boat that the author made a very interesting and enjoyable trip as a guest of the Aquarium



A SAWFISH ON THE MIAMI AQUARIUM DOCK

Sawfishes are among the most interesting of the creatures that live in tropical and subtropical seas. Their "saw" is an enormous, flat prolongation of the snout, armed laterally with sharp teeth. Specimens about 14 feet in length including the saw are of not uncommon occurrence. The present specimen is intended for the laboratory but live sawfish have been on exhibition at the Miami Aquarium. A female was taken in a net and shown for three weeks in a 36-foot tank. She gave birth to nine young, which, according to a recent report, were all still alive and growing. The mother died on March 3 of the present year, having refused to eat

by the mass of free water thus contained within her hull. One would not recommend a trip on a "well"-boat to anyone with a tendency to seasickness.

One of the most interesting creatures placed on exhibition in the aquarium last February was a large female sawfish, measuring 14 feet, 9 inches. She had been there but a few days when she gave birth to a brood of nine young. Sawfish eggs, like those of most of our sharks, hatch within the body-cavity of the mother, and when the young issue into the watery world, they are fully developed replicas of their parents, except that the prongs along the sides of their diminutive saws are set in a protecting membrane. In the spring one frequently comes across little fellows about two feet in length from tip of saw to end of tail, navigating the shallows near shore.

In the popular mind some confusion exists between the sawfish and the swordfish, which are very unlike and entirely unrelated creatures. The swordfish is a big, swift-swimming, offshore, mackerel-like wanderer. Its nose is produced in a long, flat, bony, smooth-edged blade, which it sometimes drives into the timbers of ships with great force. In the waters about Block Island and to the eastward it is the basis of a considerable fishery, swordfish having long been esteemed a delicacy in New England. The swordfishes of the Northeastern States apparently feed at a considerable depth. They are harpooned while swimming lazily and aimlessly about the surface of the summer sea, apparently resting, their tall back fin cutting the surface of the water like that of a shark. Big-game anglers of the Pacific coast sometimes take swordfish on rod and reel trolling at the surface, as they do the Japanese spearfish, known locally as "marlin swordfish," while by them the true swordfish is called "broadbill swordfish."

The sawfish, on the other hand, is a member of the shark tribe. To be more precise, it is an intermediate stage between the shark and the skates, a group of sharklike fishes which have become flattened dorso-ventrally so that they may lie on the sea bottom. Its back is rounded like that of a shark, but its lower surfaces are flattened, and it is found close to the bottom in shallow water. Its hide is quite sharklike, covering the flipper-like fins, as does that of sharks, and similarly reinforced with minute, hard, bony points; it is entirely without scales. Excellent leather can be made from the hide of this fish as from that of sharks.

The sawfish's saw is no less remarkable than the swordfish's sword. Like the latter, it is a bony, flat prolongation of the fish's snout, but it is blunt at the end, and covered by the same skin that envelopes the body. In each margin of the saw are set a series of sharp, flat teeth. The purpose of this remarkable structure is not satisfactorily known. It is a dangerous weapon, which its owner can, and doubtless sometimes does, use in defence. Furthermore, we find casual observations of its being thrashed from side to side effectively in a school of small fish, killing or disabling members thereof, which the sawfish can later pick up at leisure. To judge from its fine, granular, skatelike teeth, however, the sawfish should in the main be a bottom feeder, eating crabs, shellfish, and such hard-bodied animals. The saw may be effective in raking these out of the sandy bottom, but traces of wear sometimes found on it are the only evidence that it is so used.

Our Florida sawfish commonly reaches a length of 14 feet from tip of saw to tip of tail. An excellent cast of an individual of about this size, obtained by the Fabbri Tekla Expedition in 1910, hangs over the second floor entrance to the lecture hall in the American Museum. A sawfish, 14 feet in length and weighing 600 pounds, has been taken on rod and reel at Fort Myers, Florida. One can imagine what a fight it must have put up!

One measuring 17 feet, 8 inches, was harpooned at Cape Sable, Florida, in March, 1918, by Mr. Van Campen Heilner.

The fish department of the American Museum welcomes the installation of this collection of living fishes on the distant shores of Florida. There has already been friendly coöperation between the two institutions advantageous to the department of ichthyology. Our research work is almost entirely with preserved material, which, though itself lifeless, is of the greatest interest for the light it throws on that natural phenomenon, the living fish.

The writer has recently been working on the structure, relationships, and differences of a group of free-swimming, warm-water fishes known as jacks or crevallys. For this purpose the American Museum's collections of fish preserved in alcohol, numbering specimens of various sizes and ages and from different localities, furnished the essential material. However, ten minutes spent before a tank in the Miami Aquarium, where four species of jacks were swimming together, supplied data for this particular research problem, as to life-color variations within each species, and color marks diagnostic of each, which had not previously been obtained. On the same trip this data was verified and extended by the review of a great deal of fresh material brought to the fish market at Nassau, Bahamas.

It will be worth while to make a slight digression and describe the life colors of one of these fishes, on account of their exquisite beauty. The fish in question is the yellow jack, *Caranx bartholomaei*, the "cibi amarillo" of Spanish-speaking islands. When young, it is golden olive with irregular bars of silvery white along its back and belly and spots of the same tint on the side, and it has a diffuse, dusky bar through the eye. This mottled color gives it a low visibility about the drifting sargassum, or gulfweed, where it hides when small; the color is lost as the fish grows larger and swims boldly out into wide stretches of open water. Its general color is now bluish silver, more or less suffused with olive yellow, and with rich blue, purple, and sometimes green reflections, and becomes white on the mid-line below. The top of the head is olive and the mid-line of the back yellow, sometimes an olive yellow, and again an orange yellow. The iris is golden, and the fins grayish and olive yellow.

Dr. E. W. Gudger, of the American Museum, has for several years been especially interested in the remoras, or sucking fishes, which attach themselves by means of an oval structure, with slats like a blind, that is situated on the top of the head and front part of the back, to sharks, turtles, and other large marine creatures, obtaining free transportation in this manner without effort on their own part. The director of the Miami Aquarium is keeping a special lookout, in the interests of Dr. Gudger, for material bearing on the study of this group. Perhaps it will be possible to determine what manner of fishes were the remora's ancestors, something which has never been satisfactorily worked out.

The scope of this aquarium is in no sense narrowed to fishes alone. Indeed, the Miami Aquarium Association's first expedition of moment was to re-locate and study a colony of flamingos, which strange, large, bright-colored, wading birds still nest in the difficult tidal swamps of Andros Island, the largest but least known of the Bahamas. Especial attention is given to the difficult task of keeping in captivity various marine invertebrates. During the writer's visit some basket starfish had just been successfully installed, and an outdoor tank of young loggerhead turtles was of much interest. But the ichthyological side of the aquarium's work is the one which has been emphasized, and quite properly so. Fishes are the class of animals which make up most of the exhibits and which occupy the major part of such an institution's attention.

BANDED EPEIRA COCOON

The cocoon of the banded epeira *Metargiope trifasciata*, differs in shape from others and may be found in the autumn attached to grasses or low shrubs. After the fabrication of the cocoon, the spider soon passes away

THE MUCH DESPISED SPIDER—HARMLESS, BENEFICIAL, INTERESTING*

BY

WILLIAM M. SAVIN

THE lover of nature who neglects to pay some attention to spiders loses an opportunity for securing much enjoyment. Their abundance, their harmlessness in spite of unfounded fears to the contrary, the ease with which they can be observed, and the great variety of interesting habits exhibited by them, make them very available and profitable subjects for study. As I have said elsewhere: "If spiders did not occur in our fauna, and if the keepers of a zoölogical garden were to bring from some remote part of the world living examples of the little animals that spin from their bodies threads of silk of different kinds, some dry and inelastic, some viscid and elastic, and some, as the hackled band of *Filistata*, of wonderful complexity of structure, and with these threads construct snares of surprising regularity for trapping their prey, the presence of such marvelous animals would attract general attention, and we would make long journeys to see them. Fortunately, however, this marvel can be seen at home by anyone that has eyes and will look."

Comparatively few people study spiders seriously. It is, therefore, a matter for gratification when one appears who not merely observes what has been described in books, but adds to our knowledge of these creatures, as Mr. Savin is doing.—J. H. COMSTOCK.

SOME years ago in the introduction which a well-known naturalist had contributed to a nature book, I was somewhat amazed to come upon a statement to the effect that he had never been greatly interested in spiders but had often wondered how a certain one had managed to stretch a web about his height from the ground across a woodland road. While he but voiced a prevalent indifference to spiders, a little investigation of their habits will show that this attitude is ill-taken, for there are few creatures in small animal life so interesting in their ways and at the same time so beneficial to man, owing to the large number of insects they destroy. Moreover, being carnivorous, they never ruin anything in vegetable life.

The almost universal aversion to them is probably due to an erroneous idea that their bite is dangerous. While the tarantula, a habitant of the south, may inflict serious injury, northern spiders are virtually harmless. It is encouraging to know that their lonely manner of living makes the spiders timid and that, when disturbed, their effort is to get away; nor do they stop to administer a bite before retreating. Should a person happen to be nipped by a northern one, the amount of poison injected is too small to cause injury, even though it is sufficient to kill an insect.

Age and ancestry always command a certain amount of attention. The spiders justly lay claim to an ancient pedigree, for the nascency of the earliest species was in the Upper Carboniferous Period, at the time of the formation of the Appalachian Mountains. Fossil remains of spiders have been discovered belonging to a number of periods of our geological history. The most ancient ones have been uncovered in the coal measures at Mazon Creek, Illinois, and in shale in Upper Silesia. The appearance of spiders antedates by many millions of years that of some of our most wonderful insects, such as bees, wasps, and ants.

Unlike insects, spiders do not undergo metamorphoses. The female lays a mass of eggs around which she fabricates an egg sac or cocoon and when the young hatch, they make their appearance as small but perfectly formed spiders. To reach maturity they need only to grow and to develop certain organs, molting a number of times while doing so.

If the spiders located at the place where they emerged from the egg sac, they would not be scattered enough to prove of great economic value, and although they can live a long time without food, under such overcrowded conditions sufficient nutriment would be lacking, especially when they reached

* Illustrations from photographs by the author.

the adult stage. Their recourse would be cannibalism and that, in course of time, might decimate many species. Nature employs an ingenious device for scattering them, by endowing a great many species with an instinct to migrate by means of ballooning. This is accomplished by the spider's standing in an open place with abdomen elevated, and projecting from the spinnerets a line of silk, which continues to issue until the spider feels the pull on it by the wind. The spider then releases its hold on its support and, clasping the line, is borne away by the wind, hundreds or thousands of feet. In driving along country roads in the autumn, quantities of these lines may be seen floating through the air, bearing spiderlings which are ready to migrate at that time. Often the lines are caught on telegraph wires, fences, and other objects. As a rule, only the very young engage in migration by ballooning and the spiderling usually makes its home near the aëronautic landing place.

In order that the various species may be assured of perpetuation, it is necessary for them to provide a sufficient number of offspring to offset the loss from the many mishaps that befall them. It is quite common for parasites to infest egg sacs, thereby ruining the chance of a prospective family, and spiders that inhabit exposed positions are in constant danger, so much so that but a small proportion reach maturity.

Spiders are greatly reduced in numbers by cannibalism, which is practised while in the egg sac and just after leaving it. All the inmates of the egg sac do not shed their skin simultaneously and those already molted pounce upon those molting later. This requires no prowess, for those casting the skin are in an enfeebled condition. It is not improbable that nature furnishes spiders their food in early life in this way, the large number of eggs caring for cannibalism as well as other losses.

Evidence of the maternal instinct is confined largely to the time when the female fabricates the egg sac. Having performed this task, her mission is ended and among most genera she dies shortly afterward.

In a few genera, the mothers are on hand to welcome their offspring at birth and for a while exercise more or less care over them. The various genera have

Open door of burrow of trap door spider (Ctenizinæ). The burrow and under part of lid are lined with silk. The lid is covered externally with the same material as that which surrounds the burrow, making discovery difficult

The egg sac of the orange garden spider, *Miranda aurantia*, or *Argiope riparia*, as she has come to be called more recently, may be found attached to some herbaceous plant or shrub late in the summer

differently shaped egg sacs, which are placed in a variety of positions for safety. Ordinarily only one is fabricated by a female, although several may be made at short intervals; in such cases, the mother usually keeps them in the web near her.

The pear-shaped egg sac of the orange garden spider (*Miranda aurantia*) is fabricated in the late summer or early autumn and is a masterpiece. These egg sacs are firmly attached to some growing thing, but the spider frequently displays her ignorance of botany by placing them upon herbaceous plants or long grasses, which fall to the ground in winter. Thus the egg sacs are sometimes destroyed, for though virtually water-proof and air-proof, they are not entirely so, as I have found by testing them.

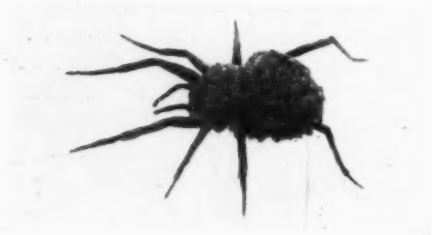
The silk of the covering is like parchment and the deep layer of fluffy, brown silk beneath it keeps the young warm and serves as a playground. It also holds the egg cup in position in the center of the egg sac.

The eggs hatch in a month or so and the young remain within the egg sac until late in the following spring. One egg sac that I opened late in the fall and found filled with young proved very interesting. It was kept in a closed house through the winter and by spring the young were reduced by cannibalism to about one quarter of the original number. In May what was left of the family was placed outdoors on a shrub and late in July there appeared a colony of adult spiders with a handsome dark-brown background and yellow markings instead of the usual black background and yellow. The color change doubtless was occasioned by the fact that the young spent the greater part of their time in an environment different from the ordinary.

In a general way, spiders may be divided into two groups, the wandering and the sedentary. The wandering go from place to place within a limited area, in search of their prey, and with one exception spin no webs. The sedentary localize and during the season may be found on or near webs they have spun, waiting for their prey, the coming of which is, of course, entirely fortuitous. When walking across meadows, one is usually repaid for overturning logs and stones by finding a *Lycosa*, or wolf spider, so called from its manner of stalking prey. Many of these have a burrow, which is often a well-made tubular retreat, lined with silk. From it they wander in the vicinity. At the time of

oviposition, the female lays several hundred eggs, which she encloses in a spherical sac, and this is dragged behind her, attached to the spinnerets by silken threads. In about a month the eggs hatch, whereupon the mother opens the sac. The young emerge and climb up her legs on to her back, where they form

Lycosa and Egg Sac.—After fabricating the egg sac the *Lycosa* drags it behind her, attached to the spinnerets by threads, until the eggs are hatched



Lycosa and Young.—As the several hundred young lycosids hatch, they climb up the mother's legs to her back. She carries them around with her for a considerable period. They do not cover her eyes or legs, leaving her free to wander. So far as is known, the spiderlings are not fed by the mother

a many-layered mass, which is carried by her until the brood is ready to migrate, an event that in some species is postponed for seven or eight months. It is not known whether the young are fed by the mother during that period. Fabre advanced the opinion that they are nourished only by the sun's rays. There is a right and a wrong way, however, to introduce them to those rays, as I learned one hot summer day, when photographing a newly emerged family in process of climbing to the mother's back. They were of pin-head size, but owing to their activity, a long exposure could not be given for the picture, so they were placed in the sunlight for a moment. Immediately all fell over dead, numbering over two hundred and fifty. The mother, too, succumbed to the sunlight.

If one tries to take the egg sac from the mother, she is greatly disturbed and will fight for it, but after the young emerge she appears indifferent to their fate. One time when I tried to capture a female laden with young, her charges tumbled from her back, but she made no attempt to recover them. Her only thought seemed to be to escape and hide. The little ones were widely scattered and exhibited an interesting phase of instinct by quickly huddling together in layers similar to the mass on the mother's back.

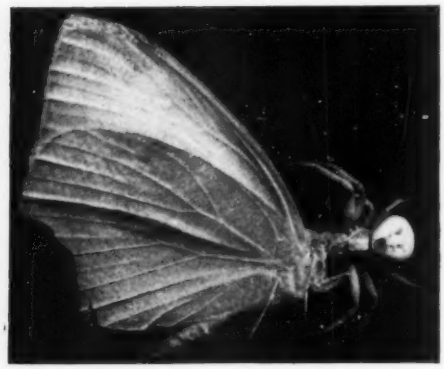
The lycosids, pisaurids, and their allies are considered the best developed physically of the spiders and are fierce fighters. If two of them be placed near each other, it usually means a swift combat and death to one of the antagonists.

Some species of these families are large spiders—over an inch in length—and several of them run on the surface of water. They live for two years or more whereas the life cycle of most spiders is but a year.

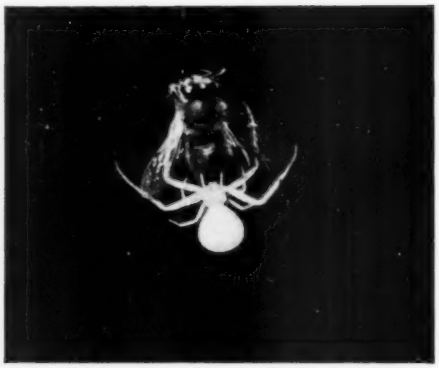
Another spider of the wandering type is the crab spider, so named from its general appearance. The front legs of this creature are long and curved inward, enabling it to walk sideways and backward more readily than forward. These spiders are of various colors and are generally found around logs and stones. The most common one and at the same time a most interesting one is the *Misumena vatia*, the female of which is half an inch or less in length and the male still smaller. This species is white or yellow, and frequently has crimson markings along the sides of the abdomen and the region of the eye. It generally locates in flowers, where it

NURSERY WEB OF PISAURID

After emerging from the egg sac the spiderlings remain for several days in a nursery of leaves folded and fastened by silken threads of the mother's spinning. The mother is on guard outside the nursery and seems to depend on her sense of feeling rather than of seeing to protect them. If she rests in a position where the connection between her and the nursery has been cut and an insect is placed in the web close to her, she pays no attention to the intruder



Not always is the crab spider, *Misumena*, engaged in killing useful insects like the bees. It is here seen clutching the butterfly, *Pieris rapæ*, whose well-known green caterpillars are so destructive to cabbages. The grip of the crab spider on its victim is a tight one. In order to take this photograph, the creatures were placed in a jar of cyanide potassium. When taken out, the grip of the spider in death seemed to be as tight as it was in life



It is said that the crab spiders, *Misumena*, always attack a bee so as to affect its nervous system, and that the assault is made in such a way that the bee is unable to administer a sting. The effect of the poison seems to be instantaneous. After the attack the spider sucks the juices of the victim. These spiders do not spin webs to capture their prey; instead, they lie in wait on plants, ready to seize a visiting insect

waits in ambush to attack a visiting bee or other insect. The color is protective, white when on a white flower, yellow on a yellow one. Should it leave a white flower and locate on a flower of yellow color, its color change is effected in less than a fortnight. It has been reported that these spiders assume also colors other than white and yellow.

The Attidæ, or jumping spiders, are mostly small, hairy ones of the wandering type. They are inconspicuous, but some of them are beautifully marked. Their short, stout legs enable them to jump readily. This is one of the families in which the mother is present to care for the young at their birth. Interesting accounts have been written about the males dancing before the females, when courting them. In the autumn, the young Attidæ may be found in nests built by the mother on wild carrot, or other wild flowers, where they locate for the winter.

It is a common occurrence for the orb-weavers to shake their webs when alarmed, but none of them performs to the same extent as the *Pholcus*, which can be kept actively swinging the web for some twenty minutes if it be touched up a bit when about to quiet down.

The female encloses the eggs in an almost invisible sac and carries it held fast in two grasping organs located above the mouth, with which the spider normally clutches and kills its prey.

Of the sedentary spiders, the most common one in our fauna is the grass spider (*Agelena nævia*), which is found on the grass, about shrubs, in the angles of buildings, and in other places. One gets an idea of their abundance, when on a summer morning, following a clear night during which a heavy dew has formed, one notes spread over the grass hundreds of their webs, sparkling with moisture and thereby made visible. In times of drought, the collection of dust upon their webs along roadsides also makes them conspicuous.

The web is sheetlike with some irregular lines above it forming a barrier web, which aids in arresting passing insects and causes them to drop to the sheet. At one side of the sheet a tubular retreat runs downward with an opening below to allow escape. The spider hides in the retreat, facing the sheet and when the

insect drops onto it, rushes out and bites it several times. The victim forthwith is carried to the retreat, where the spider feasts upon it by sucking the juices from it.

Some grass spiders appear to possess a habit peculiar to the species. From fear, or from anxiety lest the prey escape, before biting it, the spider will run around it many times in a circle having a radius of about two inches, leaving a drag line behind her as she travels, so that no matter in what direction the insect tries to depart, it will be obliged to pass through the mesh of new lines and thereby become entangled. The spider then successfully attacks it at leisure. The grass spider is readily recognized by the two spinnerets that protrude from behind the abdomen. This is unusual, as the spinnerets, thumb-like organs, are located on the ventral side of the abdomen, near the caudal end, and cannot be seen on most spiders unless that side of the spider is visible.

The silk is liquid within spiders and hardens as it comes in contact with the air. Several kinds of silk issue from the spinnerets and the spiders employ that which is suited to the kind of work that engages them.

Most people have seen the domestic spider (*Theridion tepidariorum*) the web of which is frequently found around the ceilings in houses. When an insect, usually a fly or mosquito, alights on the web, the spider rushes to it and throws over it a sheet of silk, during the flow of which she keeps turning the victim over with her hind legs to swathe it completely. She also gives it a bite and generally drags it behind her to a thicker part of the web, which she uses for a resting station. There she feasts upon it at leisure.

One summer's day at nightfall I found a male visitor of this species on the web of a female and placed a fly on the web. Both rushed for it, but as the male happened to be the nearer, he swathed and proceeded to devour it. The female seemed to be greatly annoyed and pulled

TWO HANDSOME ORB-WEAVERS

Left.—The adult female *Aranea gigas conspicellata*—a variety of *Aranea gigas*—may be found in late summer. It is one of the handsome spiders of our fauna, a symphony in brown and yellow. *Aranea gigas* is an exceedingly variable species whether considered from the standpoint of size, markings, or color.

Right.—The female *Leucauge venusta* is a beautiful spider—green, silver-white, and golden. She is between one fifth to one fourth inch long and one needs to use a magnifying lens to see her full beauty revealed. Her mate is only half as large, but is similarly colored

WEB OF FEMALE ORANGE GARDEN SPIDER

The name "garden spider" seems inappropriate for this spider. Although she is frequently found on shrubs and in gardens, her natural habitat is meadows and marshy places. This spider is known technically as *Argiope riparia* although called until recently *Miranda aurantia*. Butterflies, an occasional cicada, and other insects are found on her web, but her principal food is grasshoppers.

When a luckless creature has become entangled in her web, she rushes upon it, and fastening a swathing band to it, the product of her spinnerets, rolls it over two or three times until it is securely wrapped in its shroud. A quickly delivered bite gives the *coup de grâce*

THE COMPOSITE WEB OF THE LABYRINTH SPIDER

The web of *Metepeira labyrinthea* is of unusual form in that it consists of an irregular network of lines in addition to an incomplete orb. The female encloses the eggs in several egg sacs, formed at intervals during the laying season. The first egg sac is placed near the entrance of the retreat, the others successively in line below it, attached to a stout cord of silk. The support of the egg sacs is made so strong that they hold their position thus suspended notwithstanding the winds of winter and the driving snow

at his hind legs for some fifteen minutes while he fought her off as best he could without turning to face her, feasting as he fought. She then became resigned and returned to her former position many inches from him. When I placed another fly in the web, the female promptly ran to it and swathed it. She again returned to her original position, dragging it behind her, but in doing so, she took an indirect route in order to pass the male and gave his hind legs several additional yanks, apparently to apprise him of her good fortune in also securing prey. Fortunately his life was not in jeopardy, for the females of this species are only slightly larger than the males and are more amiable than those of the genera which destroy their suitors even without apparent provocation.

The orb-weavers are the builders of the beautiful webs of wheel-shaped form. Their young build a new web daily, thereby acquiring practice, and some adults spin theirs as frequently, but usually the web is rebuilt only after it is partially or entirely destroyed. Before starting a new web, the old one, excepting the foundation lines, which are considered too valuable to dispose of, are gathered into a small pellet, which is dropped to the ground. In making the pellet the spider uses its jaws and thus the impression is sometimes conveyed that the spider is eating its web.

The female *Verrucosa arenata* is a handsome Southern spider occasionally found as far north as New York City. Some of its habits, as noted in the text, differ from those of other orb-weavers, making it a creature of unusual interest

Sundown is the favorite time chosen for constructing a web; still some genera, especially those that resort to woodland places, often build them in the daytime.

When a web is built on a shrub, the spider often constructs it by running up and down the branches and placing a foundation line between the ends, but in the event that the web is projected across a path, or other opening, the spider stands in an open place with body elevated, back to the wind, and issues a line of silk from the spinnerets until the wind blows it far enough to catch on to some object. This becomes the foundation line and below it the web is formed. The construction of the web usually requires a little less than an hour. The males build webs, but they are usually inferior to those of the females.

The radii are not sticky, and these are used by the spider when passing over the web. The spirals or cross lines are viscous and while having the appearance of being curved, are straight, as are all other lines made by the spider. Viewed under a microscope the spirals, with their globules of sticky matter, are as beautiful as a pearl necklace.

When an insect alights on an orb web, it is caught by the viscid spirals, which hold it until the spider rushes up and swathes it with silk, turning it over repeatedly with her hind legs while so doing. The victim, then wrapped like a mummy, is generally also bitten before the spider takes it to the hub, or retreat, to be devoured.

Some spiders occupy the center of the web, the hub, night and day, others only at night. The latter in the daytime rest in a retreat to one side of the web. Such a spider lies in the retreat, facing the web, with a trap or telegraph line attached to her front legs and running to the center of the web. When an insect alights on the web, the trapline notifies the spider of its arrival.

A few years ago in New Jersey, I found

a southern spider, *Verrucosa arenata*, which is occasionally seen as far north as the latitude of New York City, and so far as I can ascertain, has a unique way, which I have tested several times, of entangling the insect which alights on her web. Instead of employing the usual method of swathing the insect, she sometimes simply used a number of the spirial lines nearest to it to bind it, cutting them from the web, as she carried her victim to the hub, or she held it stationary and used some of the nearby spirals to bind it. Possibly this may have been done to conserve her supply of silk. At other times, when an insect was deposited too unwieldy to bind with the spirals, she swathed it according to the custom of orb-weavers and in doing so, showed that she varied the method for rendering the prey helpless, dependent on the exigency of the case.

In experimenting with spiders to test their behavior in the event of a mishap to the web, I found that when the web was collapsed, no immediate action was taken to dispose of the shattered fabric, excepting in the case of one species, *Micrathena gracilis*, the spiny-bellied spider, which as a rule promptly removed it, although rebuilding was delayed for some time.

Singularly interesting are the habits of the triangle spider (*Hyptiotes cavatus*), so named from the shape of its web. Over forty years ago Professor Wilder first wrote of these remarkable spiders.

Their common habitat is a pine grove, but they seem partial to dead branches of dogwood trees in the woods and they are found also in other places.

The female is only one sixth of an inch long, and the male about one half her size. This spider, possibly protectively colored, rests back downward against the twig and looks like a light brown bud.

The web is unlike that of any other spider, a segment of a circle of an orb web, frequently smaller than the size of one's hand. There are always four radial lines; these are crossed by from six to twenty-four flocculent ones, thus differing from the orb web the spirals of which have viscid beads. At the apex of the triangle proper, where the radii meet in an irregular way, a trap line extends to the spider's resting place against the twig. This is long enough for a reserve of about three-quarters of an inch and when the spider pulls the web taut, this reserve forms into a coil between the third and fourth pairs of legs. When an insect alights on the web, the spider releases its hold and the web springs forward to the length of this reserve, taking the spider forward that distance from the twig. This causes the web to collapse slightly and the flocculent lines entangle the insect. The spider again pulls the web taut and then slackens it. This is repeated a few times, whereupon the spider rushes toward the prey and as she does so, rapidly pulls the web taut and springs it a number of times—in one instance, I counted thirteen times. On reaching the insect she swathes it in the usual way. After this is done, the bundle is slightly elongate. Sometimes she continues to swathe it until it is somewhat rounded, turning it over repeatedly to form it so. She then carries it in her jaws to her resting place. When she approaches the twig, as a rule she holds the bundle at a right angle over the line and rounds it further

The female spiny-bellied spider, *Micrathena gracilis*, is a peculiar-looking creature that, if found off her web, might at first glance not seem a spider at all. The abdomen of the female has five pairs of spines. This spider builds a beautiful web of many radial and spiral lines

WEB OF THE TRIANGLE SPIDER

The web of the triangle spider, *Hyptiotes cavatus*, looks like a portion of an orb web, but it is complete. The small spider rests against the twig and resembles a bud. The egg sac of this spider as well as the creature itself is protectively colored

to her satisfaction. She then goes to her resting place, where she stations herself, facing the web, and feasts upon her victim.

When experimenting with this spider, it is best to use only small insects, owing to the diminutive size of the web, for large ones would break it, permitting the escape of the prey. Furthermore, the spider is afraid to attack large game. Small ants, such as *Lasius niger*, are about the right size.

On one occasion I found a triangle spider that performed an act of uncommon interest. After she had gone through the usual method of springing the web and swathing the ant and had returned to her resting place to feed upon the ant, I put another ant in the web and she went through the regular performance to the point of swathing it, carrying the first one in her jaws while working. Then, instead of leaving the second one in the web, where she had swathed it, she placed the two together and made one bundle of them, throwing quantities of silk over the packet and turning it over many times until it was well rounded and larger than herself. She took it to the resting place and feasted upon it. The web was so far collapsed that she paid no attention to the third ant that I furnished her.

Generally after she had captured an ant and I had placed one or more additional ones in the web, she simply swathed them and left them in their respective places, but she always carried the first bundle around with her in her jaws when she was working on the other victims. Some other species, when carrying prey about the web, drag it behind them, attached to the spinnerets.

The female orb-weavers are larger than the males. When the difference is slight, both sexes may sometimes be found on the female's web for several days living in amity. In other genera, the female is many times the size of the male, and a person unacquainted with them would never suspect they were congeneric. When this disparity in size exists, the female is, of course, dominant, and in a few genera there has developed a peculiar phase of cruelty, the female easily overcoming and devouring her suitor. Happily this savagery is practised by only a few other creatures, such as the praying mantis. If the female is not ready for the advances of the male when he courts her, she attempts to destroy him. Knowing her temperament, he always approaches her cautiously and retreats hurriedly; he may be obliged to repeat these antics many times before she accepts him. In proportion to their bodies, his legs are longer than hers and they serve him well in his flight, during which he runs away or drops to the ground, as though one of the Furies were after him; yet in her malicious rush for him, he is often overtaken and annihilated.

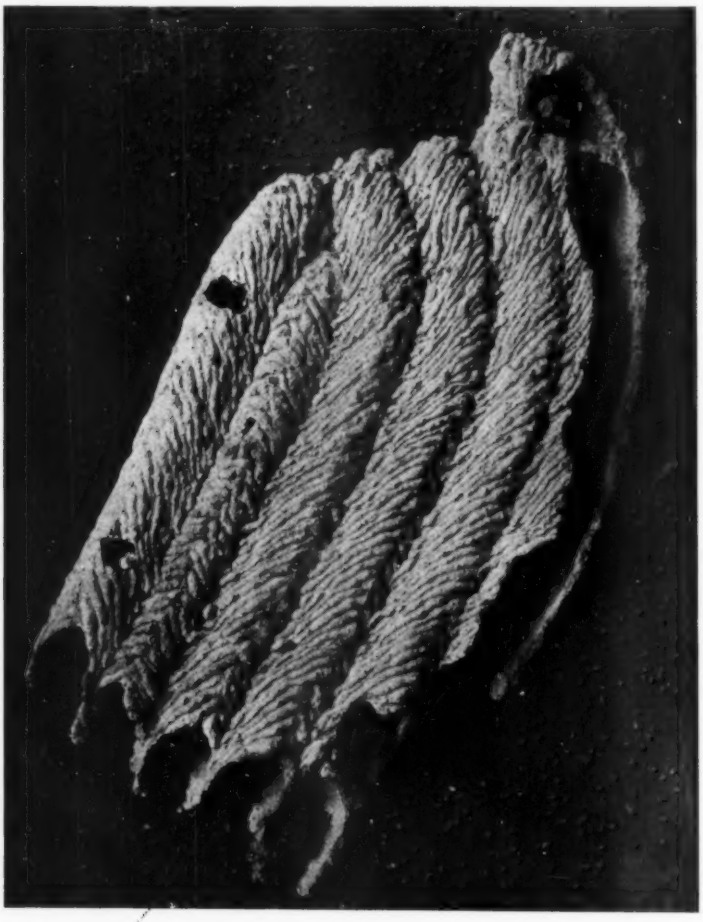
This strange ferocity is not confined to the orb-weavers. It is found also among some wandering spiders, such as the lycosids, even though these females are not much larger than the males. As these spiders are ground-inhabiting, the male is in even greater peril than the orb-weaver at the time of courtship, for he must depend on his fleetness to make his escape, while the orb-weaver can drop from the web to the ground, where the female does not pursue him.

The largest and among the handsomest of the orb-weavers are the orange garden spider (*Miranda aurantia*) and the banded epeira (*Metargiope trifasciata*) found about bushes, in gardens, meadows, and other places. The males of both genera are much smaller than the females. Sometimes finding a beau lurking around the web of a female, I have placed him on it and usually he has been destroyed. It is not unusual to find four or five males hanging around a female's web, and on one occasion, I discovered eleven awaiting a female banded epeira, which possibly possessed some rare charm in spiderdom. Spiders are polygamous and there is a difference of

opinion as to which sex is the more numerous. At any rate, the males mature earlier and as a rule are not seen as late in the season as the females. All male spiders may be readily identified by the bulbs on the pedipalps, which are leglike appendages near the mouth of the spider.

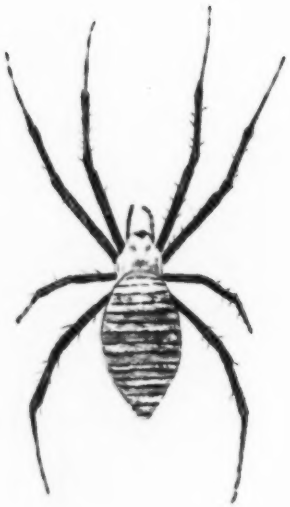
The orange garden and banded epeira spiders remain on the hub of the web day and night and, everything considered, there is probably no other spider that can be studied with such satisfaction as these.

A few visits to the haunts of spiders are likely to prove interesting enough to impel one to wander farther into this alluring field of study and with the investigation one comes into the possession of secrets which nature reveals only to those who diligently search for them.



PAN'S PIPES

The nidus called Pan's Pipes is the work of a solitary wasp, a mud-dauber. Members of the genera *Sceliphron* and *Chalybion* make nests of this general character. Each pipe is stocked with captured spiders, stung and paralyzed by the wasp as food for her offspring. After laying an egg on one of the spiders, the wasp seals the pipe. In due time the grub appears, disposes of the spiders, and after pupation emerges as a wasp. The parent never sees the offspring



TWO FAMILIAR ORB-WEAVERS

The adult female orange garden spider, *Miranda aurantia*, also called *Argiope riparia*, looks formidable, yet she is harmless to human beings. Her suitor, however, who is only about one fourth her length, may in wooing her lose a leg or two, or even his life, such is her strange ferocity toward him

The adult female banded epeira, *Metargiope trifasciata*, maturing in the late summer, is one of the handsomest spiders of our fauna. She is much larger than the male and, like the female orange garden spider, harbors an unfriendly feeling toward her suitors

SPIDER SILK AND ITS USES

BY

ALEXANDER PETRUNKEVITCH*

IN ADDITION to being of service to man as destroyers of injurious insects, spiders furnish the silk used in telescopes and various other optical instruments of precision to indicate by cross lines points in the field of vision The thinly spun but strong silk is particularly adaptable for representing fine lines of this character. The attempt has been made from time to time to utilize spider silk for textiles. About 200 years ago, in France, M. Le Bon obtained spider silk which was subsequently woven into gloves and stockings. This attempt, however, did not result in the establishment of the industry. Réaumur, appointed by the French Academy to investigate the matter, was not hopeful regarding the results to be obtained. One of the difficulties encountered in rearing spiders is that they require insect food, not easily supplied under artificial conditions, and a second difficulty is the impossibility of suppressing their cannibalistic tendencies. Dr. Petrunkevitch's article indicates, however, that formidable as are the obstacles, in one part of the world at least, the attempt to produce spider silk for textile uses has not been abandoned.—THE EDITOR.

FOR many years past the spider silk industry of Madagascar has been mentioned off and on. According to reports the spinner is a species of the genus *Nephila*, a close relative of *Nephila plumipes* of the Southern United States, Bermuda, and tropical America in general, and of *Nephila maculata* of the East. The females alone are employed in the industry, as the males are very small and do not produce silk of sufficient strength or in sufficient quantity. The creatures are kept in special gardens, taken from their webs at regular intervals, placed in special racks and allowed to furnish a certain length of silk thread, which is simply drawn from the spider's spinnerets and wound on a reel. After the performance the spiders are released and allowed to recuperate their health in the garden, as experience has shown that excessive production of silk exhausts them to the point of complete collapse.

The silk produced by this spider is finer, lighter, and stronger than silk derived from the silkworm. Consequently it is also considerably better than artificial silk now so common in the United States. There can be no doubt whatsoever that spider silk would become very popular if its price could compare favorably with the other two kinds of silk. Unfortunately it is exactly this side of spider silk production which makes it unprofitable under usual conditions and makes the spider silk itself an article of luxury. Silkworm culture is not only practicable in the temperate zone of all countries, but has been made possible even in such cold countries as Finland, through the substitution of another food plant for the mulberry. On the other hand, *Nephila* is a distinctly southern genus of spiders and like all spiders requires animal food in the shape of live insects. Breeding of spiders in captivity has never been accomplished with success and even should this ever become possible, labor conditions will counteract advantages derived from transplanting the industry to civilized centers of the temperate zone. Spider silk production will therefore remain a tropical or subtropical industry and then only in countries with comparatively cheap labor. And as long as artificial silk produced from the cheapest vegetable material is satisfactory, common mortals will hardly be tempted to pay more for something that is in no way better looking even though undoubtedly of higher quality.

*Professor of Zoölogy, Yale University

SPIDER MYTHS OF THE AMERICAN INDIANS*

IN THE mythology of the American Indians spiders played a rôle that stands in sharp contrast to the attitude of indifference or even repulsion with which the average white man views these interesting creatures. In recognition possibly of the wizardry whereby many spiders spin out of silk supplied by their own bodies the complicated structures with which we are all familiar, certain tribes assigned to the spider a prominent place in their creation myths.

Thus, according to the Sia, there was in the beginning only one being in the whole world, a spider. This spider was the possessor, however, of two little packages from each of which there evolved, in response to his singing, a woman. He continued singing and, as he sang, the world became peopled; animals and birds and all animate things made their appearance. The two women first created were the mothers of all men. From one of them are descended the Indians, from the other the remaining races of the world. The spider also created the cloud, the lightning and thunder, and the rainbow people to serve the people of earth.

Scarcely less important is the rôle played by the spider in the creation myth of the Pima. According to these people a being by the name of "earth doctor" created the world from a little dust, which he took from his breast and flattened into a cake. On this he danced and as he danced, sang. The great world expanded under his feet. This earth doctor made the sky, shaped like the round house of the Pimas, to cover his creation, but the earth shook and stretched, with the result that the sky no longer fitted the thing it was supposed to enclose. Thereupon earth doctor created a gray spider and entrusted to this creature the task of webbing together the ill-adjusted parts of sky and earth. When this task was performed, the earth grew firm and stable.

According to the creation myth of the San Carlos Apache, the big black spider, along with black metal old man, black whirlwind, and mirage, was a primordially existing being. In this myth black whirlwind rubs his hands over his breast and removes some of the cuticle, from which the earth is subsequently made, an action reminiscent of that of the Pima's earth doctor.

Picturesque is the story which the Apache tell of Naiyenzgani, the child of a woman impregnated by a ray of the sun. This youth one time set out in search of his father, the great luminary. As he was going along toward dusk, a spider spun its thread across his path and tripped him. He arose, only to fall again. He was about to persevere in his attempt when he saw, only a few inches away, the head of spider-old-woman projecting from a hole. She succeeded in persuading him to enter her house, and from the cloth which he carried attached to his shirt, she made clothing for the naked spider-girls within. We have here an unconscious forecast of the utilization of spider-silk as a textile, a subject discussed in another article of this issue. The spider-woman is undoubtedly looked upon by the Apache as the inventor of all textile art. Among the Shoshoni the spider was regarded as the first weaver, and as having imparted its accomplishment to the fathers.

The tradition of the spider-woman is fairly widespread in the Southwest—all of the Indian tribes mentioned thus far belong to this region, though some, like the Shoshoni, extend beyond it. She is spoken of at times as the mother, at times as the grandmother of the twin war gods, the children of the sun. The tradition is apparently of considerable antiquity. Among the pottery dug up at Homolobi, one of the early sites of the Hopi, was a food bowl, on the inside of which was designed a spider and on the outside, a

*The writer is indebted to Dr. Clark Wissler, curator of anthropology, and to Dr. P. E. Goddard, curator of ethnology, American Museum, for valuable suggestions in connection with the preparation of this article.

figure of the sun, tending to show that even at that early day the legend of the spider-woman's impregnation by the sun had currency. The spider-woman is an earth goddess; and as the medicine power of the sun presents itself to the Hopi as an eagle, so that of the earth is visualized as a spider.

The embodiment of the spider in Indian mythology is, however, by no means restricted to the Southwest. One of the most spirited legends in which the spider appears is related by the Mohawks. According to this legend, the spider was one of four animals that joined in an adventure to capture the sun, the absence of which had brought darkness upon the world. The sun was espied lying in a tree and the problem presented itself of dislodging it from that place of security. The beaver, one of the members of the party, began gnawing at the base of the trunk, while the spider climbed up and fastened a cord to the top, thereupon descending. When the beaver's whittling had made such headway that the tree could be felled, the spider gave a tug at the cord and down came the tree, catapulting the sun from the leafy retreat. The two animals were, however, deprived of the fruits of their toil, for the hare, another member of the party, seized the sun and bounded off with it. When finally the sun was recovered, the wise decision was reached that it should be the exclusive property of no one but should shine for the benefit of all, and accordingly the sun was hurled up into the sky to begin the journey that it has since faithfully continued.

Knowing how frail, though elastic, is the thin thread of silk that the spider spins, one marvels at the imperviousness to strain with which the imagination of the Indian occasionally endowed it. According to a myth of the Seneca, a certain web woven by a spider across a ball ground was sufficiently resistant to make a lacrosse ball rebound when striking it. According to another myth of the same people, a youth, beguiled into sleeping by the daughter of an enchantress, was borne away by her and left in isolation on a narrow cliff, from which there was seemingly no escape. Above rose a mountain precipitously to a dizzy height, below there was a sheer drop of many hundreds of feet. Similarly placed on other cliffs were youths like himself, some appearing half dead. They had all been victimized by women. Their flesh was being eaten from their bones, and yet they did not die. How was he to escape this lingering torture? Suddenly he remembered that in a dream a spider at one time had offered to aid him should he be in peril. He called upon the spider to fulfill its promise now, and presently, to his intense relief, an enormous spider, large as a man, began to weave a rope, which it let down from the mountain above. This rope was strong enough to support the man; he climbed it to safety and then, with the aid of the spider, rescued one after another the poor wretches who had shared his fate. A legend very similar occurs among the same people. Instead of being exposed upon an isolated cliff, however, the young man is pushed by an old man into the deep hole of a hollow tree trunk, filled with the moldering remains of those who have suffered a like fate. The spider invoked in this tale shows the same alacrity in coming to the rescue but unfortunately the woven ladder which is let down into the tree proves of less resistant fiber than the rope supplied to the victim of the cliff, with the result that before the young man has climbed more than half way, the ladder breaks, precipitating him to the depths from which he sought escape.

According to a tale told by the Arawak, it is not the ascent but the descent that through the aid of spiders is made easy for an escaping Indian. This people tell of a hunter who had captured a vulture—but it was no ordinary vulture, for presently the bird laid aside

its feathers and appeared before him as a beautiful girl, who became his wife and bore him aloft above the clouds. For a time all went well. In spite of the attractions of his new surroundings, however, the hunter still felt a loyalty toward those from whom he had been so unexpectedly separated and in time he expressed a wish to revisit his aged mother. This natural request occasioned a most unnatural resentment. The hunter was expelled from the regions above and placed on top of a very high tree abristle with prickly growths. He appealed to the animals to aid him and presently spiders spun cords to make possible his descent.

A beautiful myth prevalent among many Algonkin tribes and the Indians of the Plains is that of the woman who wished the Morning Star for a husband and was taken to the sky. In course of time she fell from grace and was sent back to earth, a spider being delegated to let her down by his web. Among the Plains Indians, especially the Sioux, the web is a symbol of the sky. Its four corners are the four world quarters where the thunders live.

Perhaps a Warrau legend offers the highest testimonial to the resistant quality of spider silk. According to this legend, a woman sought escape from jaguars by climbing with her baby into the branches of a high manicole tree. The ravenous beasts, not to be deprived of their prey, dug fiercely at the roots, loosening the tree's foundations until finally it swayed and fell over. Fortunately, however, its descent was stayed by a huge spider web, in which the woman and her child were caught. The woman's father, a celebrated *piai*, apprised of her misfortune through a dream, found her thus suspended when he went out to search for her.

The Cherokee have a pretty myth regarding the spider, to whom they assign a Promethean rôle. In the beginning there was no fire and the world was cold. In time, however, the thunders placed fire in a hollow tree located on an island. The animals gazed enviously at the smoke that curled upward from this concealed bonfire, knowing that there was warmth and yet at a loss how to obtain it; so they held a council and as a result the raven set out on the quest. He reached the island and the tree, but all that he bore back with him as a result of his adventure was his blackened feathers, which signalize the scorching to which he was exposed. The little screech owl next made the trial. He reached the tree as did the raven but while he was hesitating what to do next, a blast of fiery air arose from the furnace below and nearly burned out his eyes, which are red to this day. Other owls tried in their turn but with no better success; the black snake bears today a covering of sooty scales as a badge of his ineffectual hardihood.

Daunted by the failure of their fellows, the remaining animals managed to find the weightiest of reasons for not venturing to go. Not so the spider, however. She wove a little *tusti*-bowl of her silk and fastened it to her back and set forth on her adventure. She crossed the waters, being capable of running along their surface and of diving into their depths, reached the island, and crept through the grass to the tree. She snatched up a little ember of fire, placed it in her bowl, and returned to the expectant animals.

It would be hard to say what species of spider deserves the credit for this accomplishment. The little *tusti*-bowl attached to the back of the spider suggests one of the *Lycosa* that drag about with them their egg sac attached to the spinnerets. The species *Lycosa riparia* has a range southward of the District of Columbia, which would bring it into the territory of the Cherokee. "It is," quoting Hentz, "aquatic in its habits, always found near or on water, and diving with ease under the surface when threatened or pursued." Whether this be the spider referred to or not, the

attribution of the adventure to *Argyroneta*[1] is almost certainly wrong, for *Argyroneta* is a European and Asiatic genus without an American representative.

Not always is the rôle of the spider a beneficent one. According to a Pima legend Morning Green, Chief of Casa Grande, was one time entertaining Chief Tcernatssing and his women. While a dance was in progress in which the women of Casa Grande and the visitors participated, Tcernatssing sang a magic song, enticing all the women to follow him. Morning Green strove in vain to counteract the strength of his magic. Among those whose going he was powerless to prevent was his own wife. To increase the irritation of the deserted chief, his daughter married Tcernatssing and in time gave birth to a son. Then, Morning Green, bent on revenge, sent a spider to inflict a mortal wound on the child. When, however, the boy was at the point of death, Morning Green relented and sent an herb powerful enough to avert the tragedy he had almost compassed.

Lest some one infer from this that the bites of spiders are prevailingly of serious character, it should be added that this episode took place in the Southwest, where the tarantula is found. Northern spiders are practically harmless, as Mr. Savin points out in his article in this issue of NATURAL HISTORY. A possibly injurious southern spider, *Latrodectus mactans*, occasionally reported from northern localities, is so rare in this region that it is negligible.

The Zuñi tell how "old tarantula" entered into conversation with a handsomely dressed youth and asked him whether he would not like to see just how splendid he appeared. To this end the crafty old tarantula persuaded the youth, whose vanity had been aroused, to divest himself of his finery, even to the inclusion of his turquoise earrings and his anklets of sacred white shell, and then himself donned the raiment. "Look at me now. How do I look?" asked the spider as he displayed the garments. The youth, finding the ugliness of the wearer somewhat detrimental to the appearance of the clothes, was not greatly impressed. The spider moved off a bit and, as distance lends enchantment or at least makes repulsiveness less obtrusive, the youth noted an improvement. Still a little farther off moved the spider, pretending that his only object was to gain the youth's approbation, but really intent on getting nearer and nearer to his burrow. At last he had arrived at the entrance. "How do I look now?" asked the wily creature. "Perfectly handsome," replied the youth, but as he spoke, the spider dived into the earth with the stolen finery.

The spider is frequently invoked in the formulas of the Cherokee conjurors to ensnare the souls of those whom they would bring under their evil spells.

One might recount many another myth that has grown up around the spider, tending to show what an exalted place for good or for evil—though mostly, be it said, for good—this creature occupies in the folklore of the Indian. Suffice it to say in closing, that even when treading on a spider, certain Indians will do so only after rather reverent preliminaries. It is said, for instance, of the Teton, one of the tribes of the Sioux, that when a spider crosses their path, they do not kill it in silence. Either to let it escape or to kill it without prayer would bring evil. In the latter case another spider would avenge its death. To forestall such disaster, it is necessary before bringing down one's foot to say, "The thunder beings kill you." The thunder beings enjoy immunity and through thus vicariously making them responsible for the spider's death, the real culprit escapes the punishment that would otherwise be meted out to him.

H. F. S.

[1] Nineteenth Annual Report of Bureau of Ethnology, Vol. I, page 431.

AMERICAN ELM

This beautiful vase-shaped tree (*Ulmus americana*) was photographed near Stowe, Vt. The Green Mountains are in the background. The picture was taken in the month of August and shows the tree in the fullness of its foliage

THE ARTISTIC ANATOMY OF TREES*

BY

JOHN W. HARSHBERGER†

THE artistic anatomy of trees should appeal to a large circle of individuals who are interested in botany, in forestry, in horticulture, in painting, in landscape art, and the beautiful in nature.

We distinguish in architecture the elements which enter into the building. There are the bricks, the plaster, the ornaments, the rafters, the pieces of slate, the tiles, the iron grilles, and other units which must be combined by the builder into an artistic whole.

Trees too have their architectural elements, their different plans of growth resulting in distinctive shapes. The base of the tree trunk may swell out toward the roots, so that an enlarged base is produced. This is typical of trees which grow in swamps with the ground wholly, or partly, covered with water. Enlarged bases may be due to buttresses developed as flying projections and extending outwardly in all directions so that they serve as a pedestal to make the tree more stable. The ceiba (*Eriodendron anfractuosum*) described by Kingsley in his "At Last, or Christmas in the West Indies," is perhaps the best illustration of a tree with a buttressed base. The inhabitants of the West Indies, where the species is native, use the spaces between the flat, extended buttresses as stalls for their horses and cattle. There are two forms of deciduous cypresses in the swampy districts of the southern states. The common cypress (*Taxodium distichum*) has sharp-edged basal ridges, while the other species (*Taxodium imbricarium=ascendens*), usually found in drained swamps, has rounded buttresses.

To be considered at this point are the trees which give off a mass of roots which serve to brace, or prop, them with the weight of foliage and branches above and support them against the mechanical action of the wind. This is noteworthy especially where the trees grow on a steep hill slope, for on the lower side the roots have extended themselves in rounded arches to give mechanical support. Characteristic examples of this kind of root growth are found along the banks of rivers and turbulent mountain streams where the soil has been carried away in freshets.

There are trees with stilt-like roots which elevate the branches and foliage far above the surface of the ground. The screw pines (*Pandanus*) are wonderful illustrations of this kind of root development and so are the red mangrove trees (*Rhizophora mangle*) of the tropical seacoasts. Here the whole system of roots extends outwardly from the base of the tree trunk, which is elevated some distance above the salt-water, which floods periodically the flats of oozy mud on which the flat-topped mangrove trees grow. Many tropical seacoasts, such as our Florida Keys, northern Cuba, and Central America, are fringed with mangrove swamps, which are extending gradually seawards as the impenetrable maze of mangrove roots project in that direction making new soil by catching the mud and floating objects upon which the future mangrove forest will grow.

The banyan tree (*Ficus benghalensis*) is an immense, spreading tree of India which develops aërial roots from its horizontal branches. These roots descend like hanging cables, finally penetrating the ground. Then with age they increase in thickness until they become like pillars. The branches, propped in this way, are able to grow out horizontally very considerable distances away from the parent trunk. A specimen on the bank of the Nerbudda in India covers an almost incredible area, nearly 2000 feet.

* With illustrations from photographs taken by the author

† Professor of Botany, University of Pennsylvania

Red mangrove trees (*Rhizophora mangle*) on stilt-like roots along the shore of Bermuda in June. Seaward-extending mangrove swamps are a characteristic feature of many tropical seacoasts

Hour-glass stems of Bermuda palmetto (*Sabal blackburnianum*) photographed in June

The whole is said to be capable of sheltering 7000 men.

Another fig tree (*Ficus aurea*) is known as the strangling fig. The seeds of this tree fall on the branches of some other forest tree, which serves as a nurse. The seeds sprout on the limb and the roots of the young fig are at first aerial. These aerial roots grow down into the soil in all directions and ultimately completely envelop the nurse tree, which is strangled to death and finally decays away within the surrounding fig roots until the fig tree is left in undisturbed possession of the forest area where its nurse stood originally. The false trunk of the fig shows externally that it consists of many coalesced air roots, for there are many projecting ridges which give the false stem a fluted appearance.

The cylindrical, column-like trunk of palm trees is also a characteristic architectural form. The diameter of a typical palm caudex varies little from its base to its top. This method of growth is determined by the terminal bud, or cabbage, maintaining a constant diameter, so that the stem remains cylindrical in reaching its great height. Some palm stems are so tall and slender in proportion to their thickness that they are termed appropriately flexuous, bending as they do elastically to and fro with the stronger tropical winds. The native Bermuda palmetto (*Sabal blackburnianum*), however, has a terminal bud which under seasonal differences in the rainfall varies its diameter, so that the caudex assumes an hour-glass form. Tall trees of this species show a number of superimposed hour-glasses owing to the variation in the width of the stem.

Barrel-like or bottle-like stems are found in some tropical trees. There is a native of northeast Australia (*Sterculia rupestris*) which has a stem swollen in the middle to the extent of thirty or forty feet in circumference. A small crown of branches with foliage grows out of the top of the gouty portion, which consists of soft and porous tissue. There are bottle palms (*Colpothrinax Wrightiana*), native of Cuba, which assume the same form of stem. A flask-shaped tree (*Dendrosicyos socotrana*) is found on the Island of Socotra.

The bark of trees forms one of the elements which must be considered in connection with the impression which the tree conveys to the mind of the artistically inclined student of forest botany. The upright trunk, or bole, is covered with the protective layer of bark, which is distinctive enough in most trees to become of diagnostic importance. There are some variations in the character of the bark within the same species, but the initiated soon learn to make allowance for such vagaries, usually due to the environmental conditions which were influential when the cork cambium was active in the formation of this protective covering. Bark may be thick or thin, smooth or rough, furrowed or unfurrowed. It may have large plates or small ones. It peels off in papery layers in the yellow birch and the paper birch. It is shaggy with long, bent plates in the shag-bark hickory. The white cedar and California big tree have a stringy bark, while the beech has a grayish-white, tight-fitting one. The persimmons and the dogwood have a bark of square, somewhat elevated, blocks, roughly resembling in consequence an alligator skin, and this kind of bark is found on a western juniper (*Juniperus pachyphlaea*). The shallow furrows in the bark of the western yellow pine (*Pinus ponderosa*) separate the bark into flat, reddish-brown, obliquely placed plates. The edible chestnut (*Castanea*) has long, obliquely running fissures. The bark of the buttonwood peels off spontaneously into large plates, exposing a yellow-white or a greenish, smooth, inner bark. These and the color of the bark have an artistic appeal.

As branches develop from leaf buds formed in the axils of leaves, the primary branching of stems follows the disposition (phyllotaxy) of leaves, which in general

Dome-shaped copper beech at "Awbury," Germantown, Pa. Photographed toward the close of May

Trees in the Arboretum at Aldie, Doylestown, Pa. Left to right, the trees are birch (pyramidal), Colorado blue spruce (spire-shaped), American elm (vase-shaped), maiden-hair tree (conical). The photograph was made in June

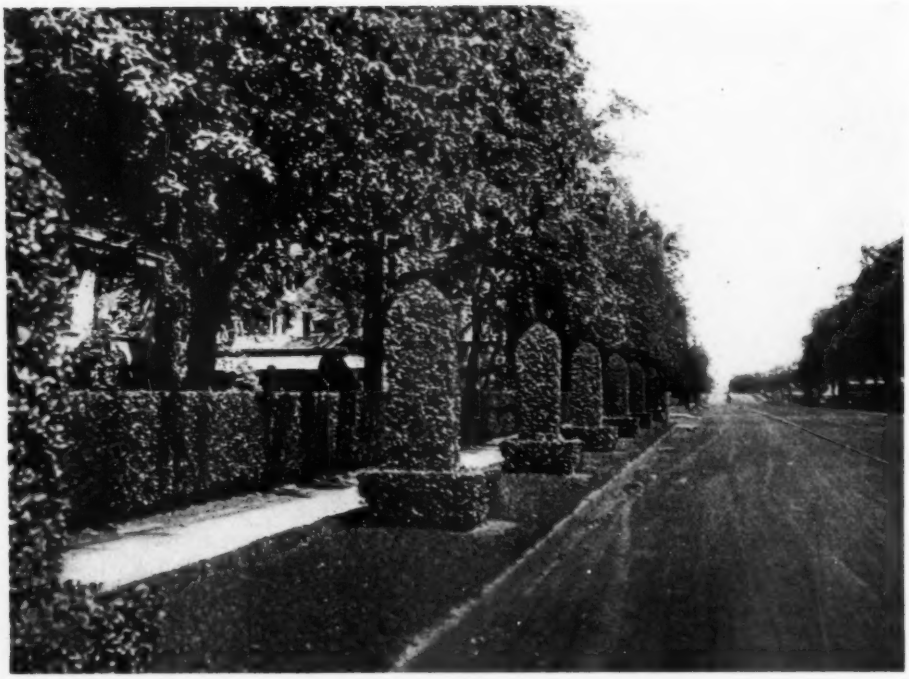
is alternate, opposite, and whorled. The beeches, chestnuts, oaks exemplify the alternate method; the ashes and maples, the opposite; the pines and spruces develop whorls of short, lateral branches. It is the character of branch development, the relative growth of the main axis contrasted with that of the lateral branches, and the thickness, length, and tracery of the finer twigs, which determine the form that the mature tree assumes. The whorled branching of the cedars, cypresses, firs, pines, spruces, and other coniferous trees with the relatively slow growth of their lateral branches, as contrasted with the rapid growth of the main stem, or leader, produces the steeple-like, or spire-shaped, tree. The cypress tree (*Cupressus sempervirens*), which is a prominent object in Italian and Persian landscapes, is spire-like. So are our red cedars (*Juniperus virginiana*), the white cedars (*Chamæcyparis thyoides*) of our eastern states and several species of western fir trees (*Abies*) found in the mountainous parts of California, Oregon, and Washington. The so-called fastigiate trees, the lateral branches of which are bent upward parallel to the main stem, so that the tree is pointed toward the top, suggesting an exclamation mark, are exemplified by the Lombardy poplar, one form of Irish yew (*Taxus baccata* var. *fastigiata*), the fastigiate tulip tree (*Liriodendron tulipifera* var. *fastigiata*) and similar forms of other exotic and native trees utilized by the horticulturist and landscape gardener.

The weeping, or pendulous, form of trees is worthy of mention in the consideration of the artistic anatomy of trees. The reader will at once recall the most typical of these trees, the weeping willow (*Salix babylonica*), a native of China, with long, cordlike, drooping branches. There are many other weeping trees, as the weeping beech, birch, mulberry, and spruce, to the scientific name of which the varietal name *pendula* is applied. Such trees should be planted sparingly with due regard to surrounding objects and the placement of them in grounds should be studied carefully; and this is true for other trees of unusual form.

The method of branching determines the shapes of the various kinds of trees. The forms of the pitch pine (*Pinus rigida*) have been studied by me.[1] The pitch pine, when growing in dense stands in the forest and under stress of competition for light, develops a central axis with all the branches disposed laterally to it, with the lower branches killed by shading and in many cases broken off, leaving conspicuous stubs. The axis is not always perfectly straight, but may be bent, or inclined, the bending being more or less S-shaped. Other trees are conical. The pitch pine responds to the advantages of free space and branches more frequently until it becomes round-headed. Occasionally the stem forks. This bifurcation may be found at the base of the trees, half way up, or near the top. Such trees are V-shaped or Y-shaped. Another form is that of the candelabra, represented by a tree which has developed with several strong branches in an open space in the woods. Some of the forest patriarchs are of this form.

There are trees of other species than the pitch pine which are round-headed (maple), dome-shaped (copper beech), conical (the half-grown Colorado blue spruce), pyramidal (horse-chestnut), columnar, V-shaped, Y-shaped, tuning-fork-shaped (resulting when the stem bifurcates but the two leaders bend inward toward each other near their tops). Some trees are cushion-shaped, basket-like (mountain pine), candelabra-like (dragon tree), vase-shaped (elm), and umbrella-shaped. The latter form is assumed by a catalpa (*Catalpa bignonioides nana*), when it receives proper horticultural treatment, and this is the form of the mature stone-pine (*Pinus pinea*) of the Italian landscapes. Such

[1]Harshberger, John W.: *The Vegetation of the New Jersey Pine-Barrens*, 1916: 53-56.



Men may with the aid of shears trim certain trees into fantastic shapes, making them formal features of a landscape. The above represents privet so treated at Allenhurst, N. J. The picture was taken in August

Weeping white mulberry (*Morus alba*) on a lawn at Allenhurst, N. J., in August

a variety is known in botany as *umbraculifera*. The cauliflower form of tree is exemplified in a species of dragon tree (*Dracæna cinnabari*) and tree spurge (*Euphorbia arbuscula*), both found in the Island of Socotra.* The traveler's tree (*Ravenala madagascariensis*) with its large, long-stalked, two-ranked leaves is fan-shaped with its leaves arranged like the outspread feathers of a peacock's tail.

Where trees are subjected to the stress of the weather, as at the seashore and on mountain tops, they assume well-known and characteristic forms which are the result of the impress of the various environmental conditions to which the trees are exposed. At those localities where the pine barrens approach the sea, as at Spring Lake, New Jersey, or the salt marshes, as at Barnegat Pier and Somers Point, the trees become reduced in size. Here they become wind-swept and one-sided. One of the usual forms is the bisected tree, where one side fails to develop, owing to the action of the wind and the sand blast in removing the buds on the exposed side of the tree. Another is the bush, or shrub, form (sheaf tree), which produces freely a number of clustered stems, more or less wind-blown. At the edge of the pine forest near the sea, low, prostrate, wind-swept trees are found, their top branches inclined, arched, or bowed in a direction away from that of the prevailing wind. Enos A. Mills describes and illustrates such twisted trees in *Country Life in America* for January, 1920 (pp. 58-59). Such trees grow at timber line in the wind-swept regions of the Rocky Mountains and other mountains of the world. They are bent, battered, and lopsided. Sometimes where the conditions are unusually severe, they crouch down behind some protecting boulder.

Gardeners can alter the form of some trees at will by the use of the pruning shears. Trees thus trimmed into desired shapes lose their individuality and become architectual or sculptural elements, expressing the will of man. This is called topiary work. We have the best examples of such topiary work in Mr. Hunnewell's grounds at Wellesley, Massachusetts, and in England at Levens Hall and Elvaston Castle. There is a portrait at Levens Hall of M. Beaumont, professor of the topiary art to James II, who constructed the gardens under the direction of Colonel Graham. They seem to have been begun about the year 1701 and have the quaintest charm in the trim and grotesque shapes of the clipped trees, the result of the care and attention of the *topiarius*. "It is an ideal and grotesque world we enter. Fantastic forms rise in yew, strange and remarkable, as far as the eye can reach, a peacock here, a huge, umbrella-like construction there, an archway, a lion and a crown, a helmet bigger than any man could wear and a host of other such creations, all shaped out of the 'ductile yew,' except that some of the smaller adornments are in box."

It is important in studying the artistic anatomy of trees to examine the tracery of the ultimate branches and branchlets, in other words to investigate the spray. This can be done best during the winter months when the trees are in the leafless condition. It may be said in general that the mode of growth in the spray corresponds with that of the larger branches. We find in the oak that the spray breaks out at right angles, or nearly so, in a series of long and short shoots, giving an abrupt ramification for which the oak is characteristic and disposed so as to give the spray a flat, horizontal appearance. In the ash the spray runs in a series of irregular parallels, because of the opposite method of branching. The spray of the elm forms a series of acute angles with the parent branch, as the branchlets come off on alternate sides, and the result is a tree which is vase-like in its general form.

*Karsten, G. and Schenck, H.: *Die Vegetationsbilder*, 3te Reihe, Heft 5, Tafeln 25 and 29, 1899.

A big white oak (*Quercus alba*) on the bank of Mantua Creek, N. J., in March. Circumference 19 feet, 6 inches

A nearer view of the same tree

The tracery of the beech against the sky line is exceptional, as the ultimate branches are divided up again and again into smaller branchlets, so that the tree has an airy gracefulness owing to the repeated subdivision of the branches into finer and finer twigs. These seem to blend with the background of the sky, especially if the sky be covered with fleecy clouds. Owing to the gray color of the twigs, the crown of the leafless tree has, seen against such a background, a hazy, misty, or nebulous appearance.

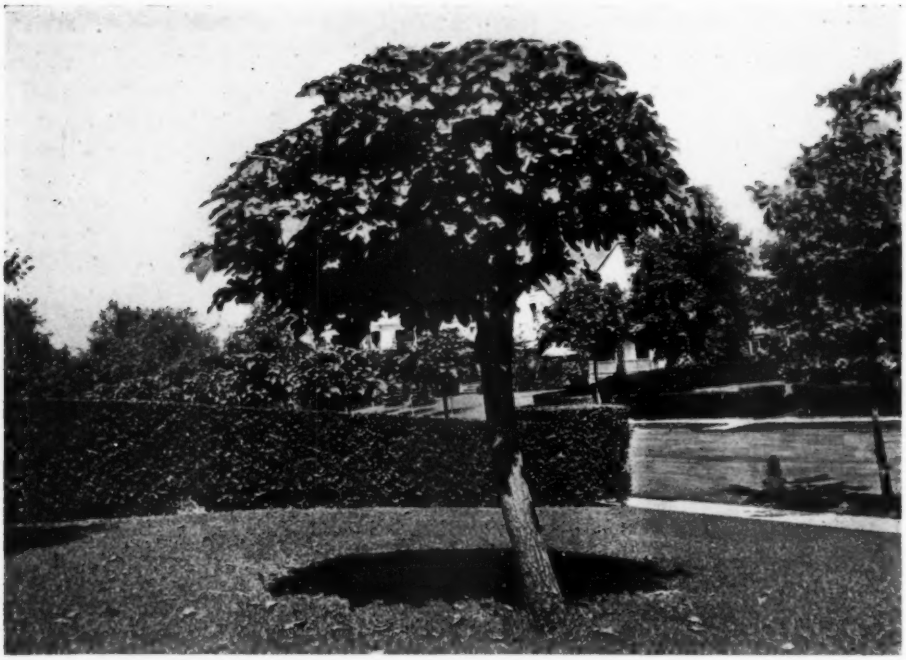
The Kentucky coffee tree stands at the other extreme, as far as its ultimate branches are concerned, for the whole branching system is open and the end-twigs are stiff and sturdy, not terminating in very fine subdivisions, as in the beech. The generic name *Gymnocladus* is expressive of the naked branches without a terminal bud and with very small lateral buds and destitute of smaller lateral twigs. The birch, when standing alone, has often an outline that is graceful and regular, for its smaller twigs are of a uniform thickness, either upright or weeping. The native dogwood (*Cornus florida*) with its rounded top has a characteristic manner of branching, for the ultimate branches are arranged in a cruciate fashion, four branches arising from the same point and spreading outwardly. Each twig of the cross is terminated by a flat, rounded bud covered with four silvered bud scales, which by growth become ultimately the attractive white bracts of the flowering period.

The twigs of the horse-chestnut are few and start without interlacement. The twigs are vertical, for they support the broad, compound leaves, and if the larger boughs are drooping, as they sometimes are, they invariably bend upward in a graceful curve at their extremities. The curves are in strong contrast to the sharp angles formed by the twigs. The circumference of the tree is greatest at half its height, and this is due to the fact that central branches spread to the longest distance away from the trunk.

The homely charm of an apple orchard appeals to most nature lovers. The topmost boughs of the apple tree grow out horizontally, thus bringing about the flattening of its crown. The branches diverge in a curious, zigzag fashion. Where the forks remain intact, they mark a stage in gradation from bough to branch and from branch to twig, but where the fork has been mutilated, there is an abrupt change from greater branch to lesser branch. These twists and unexpected angles are conspicuous, because the line of the vigorous new shoot is normally simple and upright.

Our account of the macroscopic (naked eye) anatomy of trees might be carried to the more intimate details, such as the leaf scars, lenticels, and dormant buds, the examination of which is aided materially by magnification with a hand lens. Recently several exhaustive works have appeared on this phase of botanical study. By it one is able to identify shrubs and trees in their leafless and flowerless condition. During the winter months, profitable field excursions can be made to gather and compare the different kinds of buds formed by our cultivated and native shrubs and trees, and if this study is prolonged into the spring months, the bursting of the buds, the development of leaves, and the opening of the flowers become a fascinating investigation.

A word should be said in closing regarding the planting of trees with a view to securing the most pleasing effects. The beauty of a group of trees does not consist in numbers, nor in placing together in a group trees of a great many different kinds. Rather there should be a studied attempt so to plant the trees that the reason for their growth at each particular spot in the plantation is self-evident. They must be related to contour lines of hills and valleys and disposed with reference to the rivers, lakes, rocks, pathways and roadways, houses and outbuildings of a place to produce a unification of the design. The trees may be



Umbrella catalpa (*Catalpa bignonioides nana*) at Allenhurst, N. J., in August

Wind-swept red cedar (*Juniperus virginiana*) on the lawn of a house in Allenhurst, N. J. Photographed in August

planted to produce the beautiful and the picturesque. The trees of a lawn, in order to keep their natural shape, must be protected against cattle, for soon browsing lines are found, which will efface the beauty of many fine lawn trees. "Clean, smooth stems, fresh and tender bark, and a softly rounded, pyramidal, or drooping head, are characteristic of a beautiful tree."

Round-headed trees are appropriate for introduction in highly cultivated scenery. They are not suitable for groups if used to the exclusion of other trees. Spire-shaped trees should not be planted in large tracts or masses, because of their monotonous appearance. Their general expression is spirited when planted singly or when scattered. They produce the most desirable effect among rocks and on very irregular surfaces, and especially on steep, rocky slopes. They may, however, be used to advantage elsewhere. A tall larch or two, or a few spruces rising out of the center of a group, give it life and spirit and add greatly both by contrast of form and color to the force of round-headed trees. Drooping trees, if mixed with other trees, lose their individuality. They show to advantage at the borders of groups or along the boundaries of plantations. Occasionally, a weeping beech, or a weeping spruce, may be planted on a lawn near the entrance lodge of a fine demesne with satisfactory result.

The distinctive shapes of trees, given emphasis against a background of clear sky or softly blending with it as the clouds gather or the evening light grows dim, are an unfailing source of inspiration to those who have the artistic sense.

Root system of a white oak (*Quercus alba*) photographed in early November along the road bank at Ithan, Pa.

YOUNG FAIRY TERN

Perched upon a nest of the lesser noddy (*Megalopterus melanogenys*) this young fairy tern (*Leucanous albus*), unable to fly, sat quietly while I took its picture. Adult fairy terns are pure white, and are frequently seen a hundred miles away from their island homes, fishing with sooty terns on the open ocean

VISITING THE NESTS OF SEABIRDS BY AUTOMOBILE[1]

BY

ROLLO H. BECK*

WE WERE located in Papeete, the well-known Tahitian port in the South Pacific, where we purposed beginning a study of the bird life of the numerous islands that are sprinkled over the map of that portion of the earth's surface. Our first intention was to work the nearby islands of the Society group, but after Tahiti itself had been partly explored, we heard that the trading schooner "Moana" had been chartered to go up to Christmas Island, some twelve hundred miles to the northwest from Papeete, to carry supplies to the forty odd Tahitian natives who, under a French manager, are engaged in extending the miles of coconut groves that are being developed there and in making copra. This news altered our plans. I called on the head of the company that leases Christmas Island and secured his permission to collect any birds that we might want. In addition he generously told us to make use of his residence on the island and of any equipment it contained, to the inclusion of the automobiles. Automobiling to the nests of seabirds gave promise of a new experience. I was fortunate, too, in being able to arrange with the owners of the "Moana" to have the vessel linger at the island a few days longer than the four that would answer for the discharge of the company's business.

Some days later we started on the two months' trip by way of the Marquesas Islands, where a part of the cargo was to be landed and a portion of the inward cargo loaded. Our first view of Christmas Island was of two or three little sand hills in the distance, and was obtained several hours after we should have been at the center of the island according to the morning observation of the captain. Discounting the astronomical calculation, we were sailing along to the westward, knowing by the increasing number of seabirds that we were heading in the right direction and by the noon observation of the sun that we must be very nearly in the latitude of the center of the island, the unknown strength and set of the current being a factor, however, that might divert us to the northward or to the south.

The westward trend of the long shore line led us at first to think that we were sailing along the northern coast but just before dark the mate climbed to the masthead and reported land ahead and on the starboard bow; we knew then that we were sailing into the dangerous bight on the eastern side of the island. On account of the strong current on this side a sailing vessel in a light wind has little chance of beating out of this bay, into which it may have headed inadvertently, for the entrance is wide and the low coast, but a few feet above sea level, is visible for only a short distance. We trimmed sails and started the motor, heading out to the north northwest and the next morning after navigating south southeast a few hours, we picked up the land again and sailed into the anchorage where the famous navigator Captain Cook first dropped an anchor on Christmas day, 1777.

We were rowed ashore the morning after our arrival at six o'clock and, as we landed at the wharf, found the island Ford and a dark-skinned chauffeur awaiting our pleasure. Primarily we were bound for a pond where migratory ducks sometimes stopped but really we were out for a day's collecting trip in a style that left nothing to be desired. On other tropical islands I had collected several of the species of birds we were to

[1]Article and illustrations copyrighted by Rollo H. Beck, October, 1921.

*Leader, Whitney South Sea Expedition.

see but never had my field work been carried on in the *de luxe* manner that this trip afforded. Red-footed boobies, *Sula piscator*, I had visited on the Revilla Gigedos Islands off Mexico, after climbing through cactus and thick grass to the plateau on which they were nesting; blue-faced boobies, *Sula dactylatra*, had darted their yellow beaks at me from more than one of the dark lava cliffs of the Galapagos Islands off Ecuador; as for the piratical frigates, or man-of-war birds, a species of *Fregata*, their aërial evolutions had interested me around Cocos Island, famed for its pirates' treasure, as much as their amorous performances had amused me on various other Pacific and West Indian islands. Sooty terns, *Sterna fuscata*, to the number of thousands, I had seen on lonely Clipperton Island, which lies so far southwest of the coast of Mexico that the customs officials at Acapulco, where we once called to put ashore two guardians of the phosphate company's property on the now deserted atoll, knew not of its dependency to their own republic!

To see all of these, however, from the front seat of the ubiquitous Ford in the course of a morning's drive was a thing I had not anticipated when starting for the island a month before. As little did I dream, years previous, when tramping wearily over the tundra along the shore of Bering Sea in Alaska, trying to collect a few specimens of the bristle-thighed curlew, or following the far-reaching whistle of the golden plover in a vain search for the whistler's nest in that same northern region, that I would one day sit comfortably in an automobile and collect the same birds while driving along a tropical speedway with boobies and frigate birds calling out their harsh or gurgling greetings as we passed their bulky nests along the roadside—but so it was.

A short stretch of elevated coral rock near the settlement had to be paved and the handiest material happened to be coconut leaves. At low speed the Ford went along over this piece of road very handily and after that it was good going nearly the whole distance of twenty miles or more; though at one or two isthmus crossings the sharp coral rock looked dangerous for tires, the new casings we had brought from Papeete were affected but little by the trip.

For a couple of miles after leaving London, the port settlement, the road winds in and out through the long series of coconut groves, and the marvelous skill of the chauffeur in dodging the large fallen coconuts which dotted the roadway gave constant cause for thankfulness on my part. The smaller nuts, when hit, were usually struck a glancing blow that rolled them to one side—and how the land crabs scurried! Many of the crustaceans, at the approach of the machine, dodged into holes or out of the narrow track without pausing, but occasionally one would stop to raise his threatening claws as the rushing car drew near and this show of defiance would delay him long enough in the wheel rut to endanger his life or at least to put a few legs in jeopardy.

At the last clump of coconut trees the car stopped and the chauffeur, getting out, climbed a leaning tree to drop a dozen nuts, the milk of which would quench our thirst during the day. Then, after descending, with a sharpened stick that protruded from the ground he rapidly stripped the husks from the nuts and we went on our way.

A half mile to our left was a great, sooty tern rookery with hundreds of birds circling above it and over our heads and from all directions terns were flying to or from the colony. The young birds were just hatched and as we walked through the tract, they sought shelter under every grass root and bunch of sticks that littered their nesting ground. Many of the nests were in patches of straggly shrubs about five feet high and to rise out of these was often a difficult task for the parent birds. As I made my way along a narrow path through

the colony, a flapping flock of birds would precede me, strongly reminding me of a like experience when walking through the dense colony of rockhopper penguins on Cuchon Island, one of the Falkland group in the South Atlantic.

From the coconut groves our road led to the southward over a level plain sprinkled with low bushes; trees grew here and there. Had our trip been for game birds only, we would have had good shooting at the golden plover that rose, often within easy range, on either side of the car, but being in search of larger and rarer material, we were content with a half dozen bristle-thighed curlew, which, after being skinned for specimens, served as the principal dish for the next day's dinner. It is believed that these birds, which were first described from Tahiti, nest in Alaska and migrate over the thousands of miles that separate Alaska from their winter home in Polynesia. On the other hand, the Hudsonian curlew, which also nests in Alaska, keeps to the mainland in its southern flight and during the winter time is found commonly in California.

We often encountered red-footed boobies sitting on their bulky nests of dry sticks and at last selected a nest, low down, to photograph. In some cases we found the boobies sitting on empty nests but usually eggs, and in rare instance young birds, were present.

In the lower bushes, sometimes but a foot or two above the ground, we would occasionally sight the loosely built nests of the frigate birds and several times passed shrubs with three or four of the red-pouched males sitting with extended wings and heads pointed skyward toward some soaring female that might be called to closer approach by the grotesque spectacle. When fully distended, the pouches resemble in size and color the toy balloons so desired by little children and when a bird was driven

Sitting quietly on nests in the bushy trees of Christmas Island, the red-footed boobies (*Sula piscator*) would often be passed unseen. If they happened to be facing directly toward the passerby, however, their white breasts would usually reveal their presence among the leaves

Usually the red-footed boobies fly when confronted by a human visitor, but sometimes they continue to sit closely, and rely upon their strong, sharp bills to repel intruders

from his perch with his pouch full of air, he often found it difficult to carry the load properly and would sway and turn all sorts of ways to maintain his balance. Males seemed greatly to outnumber the females at this place and when a bird, male or female, was scared from its nest, as likely as not a strange male would swoop down from above and settle contentedly on the egg while the rightful owner made vicious lunges at the intruder though without success in dislodging him.

At one place in the roadway we came to a blue-faced booby (*Sula dactylatra*) sitting on its two eggs. This species, while usually laying two eggs and hatching them, never, in my observation of dozens of nests, brings more than one of the young to maturity. I have on two or three occasions seen the older and stronger of two downy birds in a nest pecking away at its younger companion and believe that on account of its advantage in age it is able to drive the younger bird from the nest and thus secure for itself all of the food brought by the parents.

As a rule these birds nest near the shore but, in addition to nests so located, we saw two or three during the day near the center of the island, with one or both of the snowy-plumaged owners sitting or standing near by. This species and a black-headed relative in another part of the island always place their nests in a slight hollow in the ground while the red-footed booby selects a bush or tree in which to build its rough nest. The chauffeur drove the car within a few feet of sitting birds of the three nesting species and I took pictures of all three as a reminder of a unique collecting trip.

After crossing one rocky piece of road a puncture occurred, and while the chauffeur was replacing the tire, we walked on ahead and routed out from a thick bush a large black cat, the descendant probably of some tabby from one of the several ships wrecked on the eastern shore of the island. A shot as it sneaked away through the bushes saved the lives of some of the island birds. The cat may have found food, too, among the abundant crab population that flourished everywhere.

About eleven o'clock we stopped in the shade of a small, isolated group of coconut trees near which the ducks were supposed to be, but not finding them, we waded out, over a narrow isthmus covered with two feet of water, to an islet in the lagoon and there came upon numerous nests of a species of shearwater under little tufts of grass, which grew at one end of the island. Eggs as well as downy young were found and sometimes pairs of birds sitting in little hollows sheltered by the grass from the sun's rays; circling over the island were more of the birds, differing in this respect from many species of their family which only visit their nests at night, remaining miles away at sea during the daytime.

The young, when nearly ready to fly, are very fat and are taken for the grease that their bodies yield—eight birds producing a kilo of excellent grease for cooking, I was told at the settlement. The tender flesh of the young is esteemed by all the natives; in fact, we found the flesh of the old birds quite palatable, for one evening on shipboard some of the bodies skinned for specimens were served for dinner and no one refused the second helping.

The Christmas Island shearwater (*Puffinus nativitatis*) which, like all its kind, lays but one egg, frequently nests under dead coconut leaves. In the absence of coconuts it seeks shelter from the tropical sun under dense grass or shrubs

The short-billed petrel (*Æstrelata parvirostris*) a common bird at Christmas Island, selects nesting sites similar to those of its neighbor, the shearwater. This bird chose a young coconut as a shelter from the sun's rays while incubating

We did not sample the tough old boobies, several of which were shot at sea as they flew across the bow and were picked up with a net as we sailed along, but when we reached the island, the young ones were highly recommended to us and one of several gawky, immature birds we saw in a pen at the settlement was presented to us later on in the shape of a pâté as the first course of our Sunday dinner. This bird, prepared by the lady of the house in her French style, was as fine a dish as could be desired, both the captain and I agreeing it excelled the tinned meat of fancy name we had with coffee each morning.

On a point of the island where the shearwaters were nesting we shot a ruddy turnstone, a bird common on the Atlantic seaboard of America but much rarer on the Pacific coast of America, where it is replaced by the black turnstone, a near relative. A few of the turnstones evidently join the flight of golden plover, wandering tattlers, and bristle-thighed curlew that wing their way to the widely scattered islands of the Pacific Ocean in order to sojourn there while winter obtains in the Northern Hemisphere, for I saw three or four others during our stay at Christmas Island.

That some species of birds, at least, have a sense of direction far superior to that of man seems certain when one watches them at sea off their nesting grounds. Sooty terns from the Marquesas, Christmas, and Starbuck islands, to cite examples that I have been watching within the last month, range regularly one hundred fifty miles from their nesting colonies. The two islands last mentioned are but a few feet above the surface of the sea and hardly visible for more than twenty miles to fishing birds. Although probably less than half the birds do their fishing at a distance of more than twenty miles from their nests, the fact that we can see flocks of from ten to three hundred birds so engaged one hundred miles or more from an island shows that a reasonable flying distance from home presents no obstacle. That the darkness of night has no perceptible effect on their goings and comings is evidenced by their creaking cries, which one can hear at night as they pass the ship, whether one be far at sea or anchored but a few miles from their nesting grounds. Even dense fog, drizzly rain, and darkness combined do not prevent seabirds from finding their nests as is proved by the fact that several kinds of petrels and shearwaters select dense forests on high oceanic islands in which to dig their burrows and then go to them only at night.

The turnstones, tattlers, plover, and curlew that visit the islands of the Pacific Ocean must cross nearly two thousand miles of water before being able to alight on land, and present an interesting question to students of migration. Could one trap and mark one hundred or two hundred birds on an island and then trap a goodly number of the marked birds on the same island the following season, after their return flight from Alaska, it would clear up one or two disputed points in regard to migratory habits.

On our return trip in the afternoon over the morning's route we observed many more birds in the air than we saw in the forenoon. The young red-footed boobies and frigate birds particularly seemed to enjoy watching us travel along, and certain oddly marked birds could be singled out as they circled and sailed around us for several miles and swooped in their flight, finally winging their way back to their roosting places.

Sooty terns, the flight of which at our noon camp had borne off to the southeast, indicating another colony in that direction, changed their course as we approached the north end and headed northeast to the great colony which extended for nearly two miles at the northeast corner of the island. Curlew and plover were flying in small flocks to other feeding grounds along the lagoon shore and as we passed the tern colony

and entered the coconut grove, birds were flying everywhere, the greater number being sooty terns, thousands of which were still circling over their nests with continual additions to the throng from those returning from sea. A mile to the eastward scores of boobies and frigate birds could be distinguished circling over the low bushes in which their nests were placed.

Slowing down as we neared the settlement with its pavement of coconut leaves, we noted a little kokikoko, *Conopoderas æquinoctialis* (a warbler-like bird, the only land bird on this island), flit from its perch and fly across the road to a clump of bushes, where a couple of old nests could be seen among the withered leaves in the center of the thicket.

This completed the list of birds and nests observed that day, but two days later we took a sailboat and went to one of several small islets in the lagoon, where the nesting birds were principally under the bushes, grass, or dead coconut leaves. On the islet we saw many nests of the handsome red-tailed tropic bird, the two central tail feathers of which are in such demand for decorative purposes by milliners. The taking of these two feathers from the bird has none of the ill effects on this species that in years past attended the securing of birds' plumage for the headgear of ladies in the United States; it is as simple and harmless a process as going out by candlelight and pulling the two longest tail feathers out of the family rooster. In the case of the tropic bird the victim is on the ground, and if asleep, as is frequently the case, the collector walks up and with a sudden pull removes the two feathers. The bird will probably open its eyes and then, as the collector walks on, close them again and go to sleep. If awake, the bird may cackle a bit as the collector approaches, and cackle again as he maneuvers for a position out of reach of the bird's bill, which is long, pointed, and extremely sharp at the cutting edge.

In many parts of its wide range the noddy tern (*Anous stolidus*) nests on cliffs along the seashore, but on Christmas Island the single egg is usually laid on the sandy soil under a shady tree or shrub

Dangling a red bandanna handkerchief in front of the bird with one hand and dexterously extracting the feathers with the other, I found to be a very efficient method in the two or three cases where the soiled breast feathers made the birds undesirable as specimens. The manager of the company said the easiest method is to pin the bird's head to the ground with a forked stick while plucking the feathers, but I think the average American Audubonist would concede that, theoretically at least, less liability of hurting the bird's sense of dignity—though his sense of feeling would be equally affected by either method—would be incurred through the dangled bandanna.

As to leaving the nest when a man comes near, whether the bird be sitting on an egg or merely retaining ownership of the nesting spot, that is a thing it never considers, evidently believing its snapping bill to be as efficacious in driving the human intruder away as it is in forcing the retreat of the heavy clawed land

Sooty terns (*Sterna fuscata*) remained with their newly hatched young even when the Graflex was pointed at them in plain view. Unlike many land birds they do not trouble to remove the egg shell from the vicinity of the nest after the chick has hatched

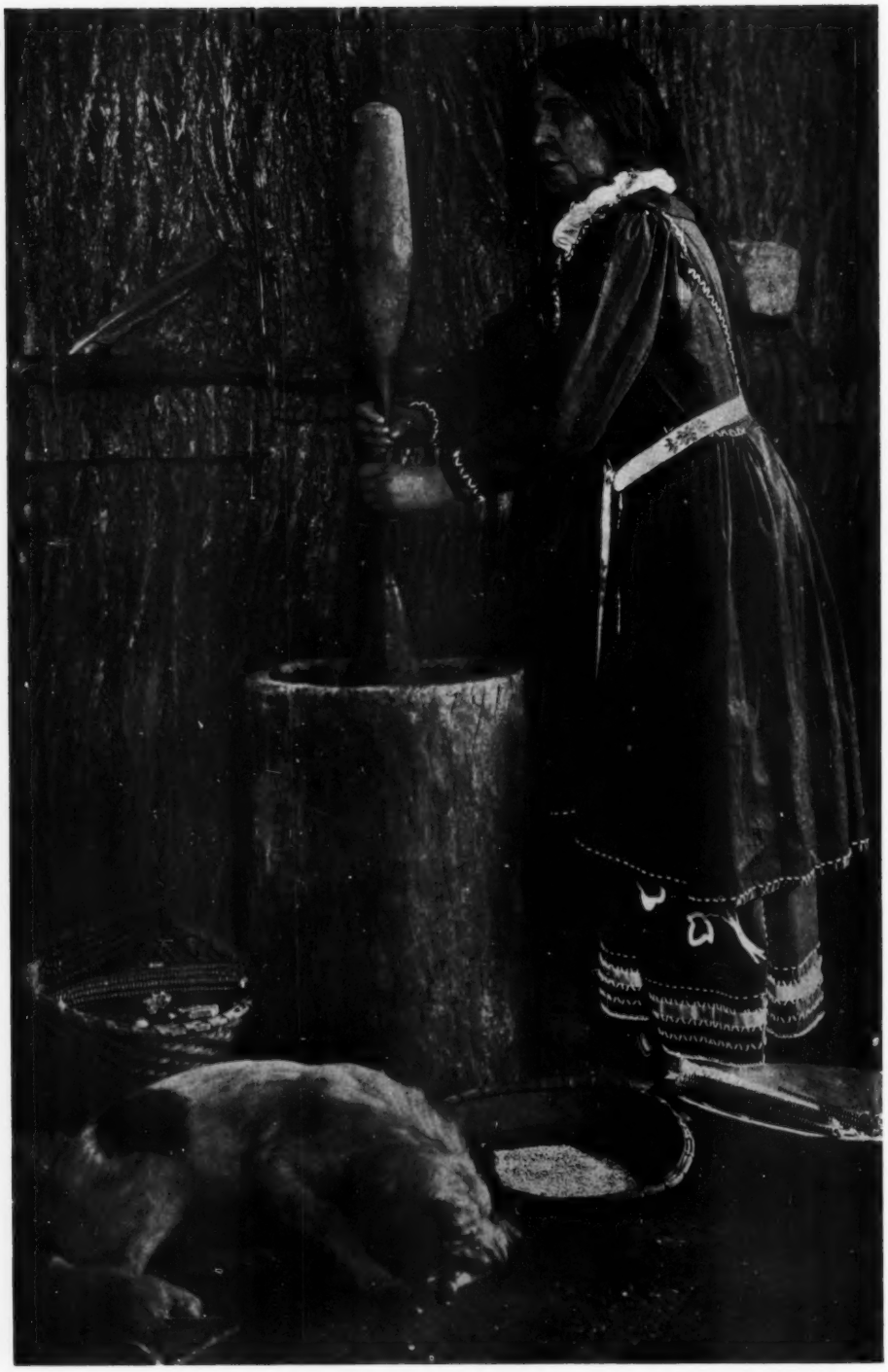
The handsome red-tailed tropic bird (*Phaëthon rubricaudus*) lays a single, heavily marked egg under some shrub or tree, where it sits sleeping during a good part of the period of incubation. If this photograph is examined closely, the long central tail feathers of the bird can be seen

crabs that are its only other source of annoyance on the lonely isle.

Just what revenue is derived from the feathers I did not learn, but that the birds are protected as a valuable asset by the lessees of the island is evidenced by the fact that the laborers are charged five francs for each feather the manager finds them surreptitiously purloining. On this little islet, which was called Motu Tabu, meaning forbidden island, the feathers of the tropic birds and young shearwaters were the two valuable articles produced, both of them being gathered by the manager, the feathers for sale and the shearwaters for food and grease. Of the shearwaters there were three kinds nesting within a few feet of one another, and at a certain spot near by we found another member of the family, a smaller petrel, making four of the tube-nosed birds breeding within a radius of twenty feet,—a closer juxtaposition of nesting species of the same family than I remember seeing elsewhere. I noticed, however, that on the same islet, containing perhaps three acres, there had nested earlier in the season four species of terns,—two of these in the same trees, a third under the trees, while distant only a few yards under the clumps of grass the fourth, a beautiful little gray tern, laid its single egg. On Cooks Island in another part of the lagoon three other species nest, making seven kinds of terns that can be observed in one day, and I am not sure that they do not all nest upon Cooks Island alone.

To a bird lover Christmas Island offers an unusual opportunity for the study of nesting habits of rare shearwaters and petrels, but as a schooner calls but once or twice a year, few will care to make the trip. We spent eight days at the island and regretted that circumstances would permit us to stay no longer for, though I have seen many colonies of seabirds and expect to see a few more before leaving this part of the Pacific, I do not expect again to ride to the birds in their rookeries in an automobile.

Photographing an unperturbed blue-faced booby (*Sula dactylatra*) at close range



IROQUOIS WOMAN POUNDING MAIZE INTO MEAL
Photograph showing elements of a group on exhibition in the American Museum

INDIAN CORN OR MAIZE

BY

CHARLES W. MEAD

INDIAN corn or maize (*Zea Mays* Linnæus) belongs in the long list of foods, fruit, and medicines that were unknown in Europe before 1492. Mention of a few items from this list makes one realize something of the magnitude of the contribution which North and South America have made to the world in the form of agricultural products and their derivatives. Potatoes, sweet potatoes, tomato, manioc (tapioca), cacao (chocolate and cocoa), pineapple, cocaine, quinine, and tobacco constitute a part of this contribution.

After the discovery of America by Columbus maize quickly spread to other parts of the world, and today it is in the foremost rank of the world's foods.

The exact location of its origin is uncertain. It has usually been ascribed to the highlands of Peru; but some recent studies indicate that it may have developed from wild grasses in the Maya region of Central America, or according to others in southern Mexico.

In prehistoric times the regions of the most intensive cultivation of corn were the eastern half of the United States and the West Indies, the region of the cliff dwellers in the Southwest, down through Mexico and Central America into South America, where it extended well into southern Chile.

Most prehistoric peoples buried food with their dead, and such of their belongings as it was thought would be useful to them in a future life. Their burial places, many centuries old, yield our collectors a great variety of corn. This is particularly true in the case of Peru, where in a large part of the country the soil and climate are very favorable to its preservation. The Peruvian collections in the American Museum contain nine or ten different varieties, and so far as outward appearance goes, many of the ears might belong with last year's crop. I am often asked if I have ever planted this corn. There is a wide-spread belief that although it is one thousand years old or more, it will germinate and grow. One has but to prick one of the fairest kernels with a pin and shake it to have the contents come out in fine dust. The germ is gone. Imagine a salesman telling a farmer, a prospective customer, that the seed corn he is offering him is a thousand years old.[1]

In no part of America was anything in the nature of a plow used. Various forms of pointed sticks, sometimes sticks with broad blades, prepared the ground for the seed. In the western parts of both North and South America the stick was usually provided with a foot rest for driving it into the earth. In the northwestern section of Peru a sort of spade was common, consisting of a heavy, chisel-like blade of copper with a socket into which the stick was forced.

East of the Mississippi a hole was dug, and a few grains of corn were placed in it and covered with fine earth. Later a hoe was used to draw the dirt up around the young plants, resulting in "hills" of corn. These hoes resemble an adz with a blade of wood, stone, antler, or bone. Although various animal manures were used, the most wide-spread custom was to place small fish in the hill with the seed, and along the New England coast the alewife or herring was kind enough to arrive just in time to be planted with the corn.

The newcomers soon learned that the young maize plants grew better if the earth was banked up around them (hilled), and the Atlantic colonies took over the Indian hoe together with the entire maize complex. When the seed was introduced into the Old World, the cultivation was carried on in conformity with the methods prevailing there.

Irrigation on a large scale existed only

[1] In this connection the reader is referred to a note regarding "mummy wheat" on p. 436 of this issue.

in Mexico and Peru. The Peruvians irrigated their fields by means of aqueducts from rivers at a considerable distance. These ancient works show such engineering skill that they excited the wonder and admiration of all the early chroniclers. One of the best preserved is near Chimbote on the northern coast. The region surrounding the extensive ruins is barren and desolate. The ancient population irrigated it by means of an aqueduct from the River Santa, sixteen miles distant. The greater part of this fine work still exists and it is computed that it has a capacity of supplying sixty million cubic feet of water daily.

The milling of corn by primitive methods was a slow and laborious process and occupied a large part of the time of the women. One method of reducing it to meal was common everywhere, that of grinding between two stones. The shelled corn was placed on a flat stone. The woman knelt beside it with a stone muller, held in both hands, which she forced forward and backward over the grain until it was reduced to the required degree of fineness. The other common method was by mortar and pestle. An ingenious device found only in Peru and Bolivia consists of a flat stone upon which the corn was placed and a large, heavy, flat stone which had been rounded on its grinding edge. The grinding edge was set on the corn and the work done by simply rocking the stone back and forth. This method requires much less expenditure of strength than when the metate and hand stone are used.

Mr. A. F. Bandelier, while collecting in Bolivia for the American Museum, excavated such a mill from a prehistoric burial place. Mrs. Bandelier, who accompanied him, tried the experiment of grinding some coffee with it. She found that it did the work so well and with so little exertion on her part that for some

Metate and hand stone

In Peru and Bolivia this ingenious grinding device is used

months she used it every day to grind their morning coffee.

Our eastern Indians frequently employed a wooden mortar and pestle. For the mortar they took a section of a tree trunk about two feet long and about twenty inches in diameter. The hollow in the upper end was produced by burning. A small fire was made in the center, and after it had eaten its way to a depth of half an inch or so, it was brushed off, the charred wood was scraped out, and another fire was kindled. This continued until the mortar was ready for use. Some tribes did not use the upright mortar, but instead burned the depression in the log as it lay on the ground. The pestle was generally about four feet long, roughly cylindrical, and much smaller in the middle where it was grasped by the hands. It was made of hard wood and the object of having the ends so much larger than the middle was to give it sufficient weight to crush the corn.

The early colonists have described in detail numerous ways in which the Indians prepared maize for food. I have taken the following recipes from the *New York State Museum Bulletin*, No. 144, by Arthur C. Parker. So many authorities, and their opinions of each dish, are cited by Mr. Parker, that for want of space I have decided to omit them all, and to refer any one particularly interested in the subject to his very valuable work.

Leaf bread tamales. This dish was prepared from green corn. Kernels were cut or scraped from the cob and beaten to a milky paste in a mortar. The paste was patted into shape and laid in a strip on one end of a broad corn leaf, the free half of which was then doubled over the paste. Thereupon it was

covered with other leaves, tied, and dropped into boiling water. When ready, it was eaten with sunflower or bear oil.

Baked green corn. Corn scraped from the cob was beaten to a paste in a mortar. The paste was put into a vessel and covered with leaves. Cold ashes were thrown over the leaves; a small fire was kindled under the vessel, and glowing charcoal placed on the ashes at the top.

Boiled green corn. This is simply corn on the cob familiar to us all.

Succotash. This was made much as it is at the present time. Corn cut or scraped from the cob was thrown into a pot of beans which had been nearly cooked, and the two ingredients were then cooked together. Salt and grease or oil were added. In certain parts of New England hulled corn has been called succotash.

Boiled corn bread. The corn was first boiled from fifteen to thirty minutes in a weak solution of lye made of hardwood ashes, until the hulls and outer skins were loosened and the corn looked white and swollen. Thereupon it was thoroughly rinsed to free it from any trace of lye. Large loaves were made and plunged into boiling water, and cooked for nearly an hour. Sometimes such a loaf was baked in hot ashes, over which a roaring fire had been built.

Early bread. Before the corn was thoroughly dry in autumn it was plucked. The unhulled corn was mixed with water and beaten in a mortar into a paste. Loaves were molded by hand and boiled. This bread was especially valued as a food for invalids.

Dumpling. A mass of corn meal was moistened with boiling water and quickly molded into cakes in the closed hand moistened in cold water. The dumplings were then dropped, one by one, into steaming water, and were boiled for half an hour. Dumplings were frequently cooked with boiling meats or game birds.

Hominy. For a family of five persons a quart of corn, four tablespoonfuls of water, and some white ashes were pounded in a mortar until the hulls began to come off easily. At this point the pounding of the pestle was quickened and ceased only when the corn had been broken into coarse pieces. The corn was then sifted by means of a basket used as a sieve. The hominy passed through and was put into a bowl; the residue of uncracked corn was pounded again. The mass was then tossed with a peculiar motion in a bowl or basket. This tossing caused the lighter chit to rise to the top, while the heavier portion stayed at the bottom. The hulls and chit were thrown out by hand or by the use of a fan made of a bird's wing. One part of the meal was mixed with eight parts of water, and boiled for two hours.

Hulled corn. This was made of some soft corn, treated as corn for bread. It was washed until free from skins and hulls, and then put in cold water and boiled for four hours, at the end of which time all of the kernels would have burst open. Small chunks of meat and fat were thrown in the boiling liquid and sometimes berries. Several canning companies now put up hulled corn under the name of entire hominy.

Samp. Corn was treated as for bread, except that it was not beaten so fine. Berries or meat were mixed and cooked with samp. Any variety of corn that would hull easily answered the purpose.

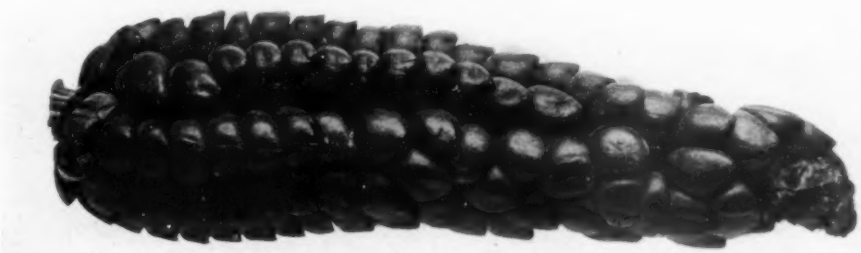
Reading these recipes brings to mind some of our familiar dishes. We now buy our corn ready ground, and cook with gas or electricity instead of by a fire in the open. The result, however, is much the same.

Corn furnished both victuals and drink to the early Peruvians. From it they made a kind of hard bread. A favorite way of preparing it was to parch it and reduce it to meal. This the Peruvians carried on journeys, in bags, and when hungry, they took a little of it with a

swallow of water. These bags are often found in graves with the mummies. The present Peruvian Indians are as fond of this food as were their ancestors many centuries before the coming of Pizarro. Garcilasso de la Vega, the old Inca historian, tells us: "They make a kind of Hasty-Pudding called *Api*, which was a great dish amongst them, and which they ate with much delight: but this was esteemed high feeding, and was not common at every meal."

When Pizarro began the conquest of Peru (1532), the common drink of the country was a sort of beer made from maize. The grains were soaked in water until they sprouted. They were then ground, boiled, and stored away until fermentation set in. When the Peruvians wished to make a particularly fine brew, the kernels were chewed by the old women instead of being ground between two stones.

It is the testimony of the Pilgrim Fathers and those in the plantations in Maryland and Virginia that without maize their settlements would have ended in melancholy tragedies. Time and again corn supplied by their Indian neighbors saved them from starvation.



Corn from pre-Columbian grave in Peru

Charred corn from pit in prehistoric communal dwelling on mesa north of Los Alamos Cañon, New Mexico

CORN CULTURE AMONG THE INDIANS OF THE SOUTHWEST

BY

HENRY M. STEECE *

THERE are few growing things that have shown a greater adaptability to the varied conditions of soil and climate incident to a wide range than has corn. In the issue of NATURAL HISTORY for January, 1918, there appeared an article dealing with Mandan corn, grown in the Upper Missouri area. The present essay has to do with corn as grown in the arid Southwest, where the necessity of reaching soil that contains the requisite moisture has led not only to deep planting but to certain adaptations in the corn itself.

Because the Indian of the region is so dependent on the corn harvest, many religious ceremonies are connected directly or indirectly with this cereal. These observances for reasons of space are not considered in this article, the emphasis of which is on the agricultural phases of the subject.

—THE EDITOR.

AGRICULTURE was in a relatively high state of development when the Spanish explorers of the sixteenth century first came in contact with the natives of what is now our Southwest. The ruins of many ancient irrigation ditches, canals, and reservoirs indicate that an extensive area was under cultivation. That corn was widely grown is shown by the discovery of whole ears and cobs and grinding boxes made of stone slabs in the cliff dwellings of the Mesa Verde region of Colorado and the Cañon de Chelly in Arizona. The cavate lodges of the Pajarito plateau and the communal dwellings of the Puyé Mesa in the vicinity of the modern pueblo of Santa Clara, New Mexico, yield much evidence of the antiquity of corn culture in the upper Rio Grande region.

Castañeda of Coronado's expedition mentioned the finding of large quantities of corn in the Galisteo Valley stored in underground chambers. His attention was attracted to the method of corn culture and the grinding of the grain with the mano and metate, both of which differ but little from the practices of the present day. When Antonio Espejo penetrated the country in 1583, he found cornfields irrigated by the waters of the San José at Acomita, fourteen miles from the pueblo of Acoma.

Writing toward the middle of the seventeenth century, Alonzo de Benavides relates that the culture of maize by

United States Department of Agriculture.

the Navajos was so extensive as to suggest the tribal name: "Apaches de Nauajò," *i. e.*, Apaches of great fields.

Corn and meal furnished excellent mediums for trade between the inhabitants of the different pueblos and the nomadic Apaches, Navajos, Utes, Kiowas, and Comanches. Men carried large quantities of meal on their backs far to the east, traveling for days until a band of hunters was encountered, when exchange was made for deer- and buffalo-hides. While exploring a railroad route to the Pacific in 1853, Lieut. A. W. Whipple met several parties of Pueblo Indian traders from Santo Domingo with burros heavily laden with corn meal. They had come as far east as the present Texas "panhandle," where they remained for nearly a week in search of the Kiowas and Comanches.

At the present day as in the time of the *conquistadores* corn and its cultivation assume a big place in the life of the Indian of the Southwest. Beans and squashes were also raised, but the Indian's chief food products consisted of corn. Maize was easily cultivated, yielded well, and was very nutritious; when dry, it was not injured by heat or cold. It could be preserved in a cache or cave for long periods, was easily gathered, and for food use required but little preparation.

The region occupied by the Pueblo and Navajo Indians in northwestern New Mexico and northeastern Arizona is a vast, arid table land ranging from five thousand to eight thousand feet in altitude, now and then broken by great mountains and wide cañons. With the exception of the Rio Grande, Rio Puerco, San Juan, San José, and Little Colorado, there are few streams furnishing water for irrigation. The precipitation of this section of the country ranges from ten to fifteen inches annually, July and August being the months of greatest rainfall; and the heaviest snows occurring in the winter months of December, January, and February.

The Indians are dependent on streams and washes for the water supply of the corn crop as the normal rainfall of the region is far too light to sustain the plants through the growing season. Where no stream of size is available, the Navajos, Hopis, and Zuñis select a sandy flat in the flood plain or wash of a large arroyo, cañon, or river, for the cornfields. The members of two or more affiliated clans will throw up earthen banks or borders to the height of two or three feet enclosing tracts about one and one half acres in area. A family often holds the same field year after year, indicating the boundaries with a fence, footpath, or heaps of stones. Ditches are constructed in such manner that when the floods of the melting mountain snows fill the arroyos, the water flows to the fields and the small tracts enclosed in the borders are completely immersed by the flood waters. The water penetrates the sandy soil to a depth of five or six feet, where it is held in reserve to supply the plants during the drought of May and June.

Where the Pueblo villages are situated near rivers as large as the Jemez, San José, or Rio Puerco, the water is conducted to the fields by means of rude systems of irrigation. During the spring months a plentiful supply is usually available, but at other times the flow of water is comparatively small. The Pueblo Indians, however, have made the most of their opportunities by combining their efforts and constructing dams of brush, stones, and mud to divert the water from the river into broad, shallow canals and thence to the field laterals, borders, and furrows. The fields, which vary in size from one half to two or three acres according to the land of the pueblo, the strength and importance of the clan, the number of individuals in the family, and the water supply, are flooded early in March or April, in order that the seed bed will be in good condition when the corn is planted.

The planting season begins about the

time of the emergence of the leaves of the cottonwood trees and the new grass, and under a waxing moon. When the Zuñi notices the new growth of the weed, *Hăsuski* (coyote-leaf; *Croton texensis*), he feels that the danger from a late frost is past and corn planting time is at hand.

The Indian now goes to the field, accompanied by his wife, who carries the

Hill of corn at Zuñi Pueblo, New Mexico. The clump included thirteen stalks and suckers

bag of seed corn carefully selected from the crop of last year. He has a straight branch of greasewood with one end slightly pointed, or a stick about three feet long, preferably a branch of piñon provided with a stub of a limb projecting out at a right angle from six to twelve inches above the point or blade. Selecting a spot near the border of the plot, he pushes his stick into the sandy soil to a depth of several inches, taking care to make but a small opening in order to preserve as much of the soil moisture as possible. His wife drops from ten to fifteen kernels into the hole, which she carefully closes and covers with a skillful movement of her foot. After the first hill is planted, the man takes two steps forward and repeats the process of planting and covering until the end of the patch is reached. He now determines the second row by taking a good, long step to the right or left of the first row and continues planting until the field is completed. By the use of this system of planting the hills are generally spaced about four or five feet apart and the rows about the same distance.

If the field is to be irrigated, the seed is not planted deeper than four or five inches, but, where the Indian depends on the summer rains for the next application of water, he will drop the corn at least a foot below the surface. Mr. Guy N. Collins found that the varieties grown by these Indians possess two special adaptations: "(1) A greatly elongated mesocotyl that permits deep planting and (2) the development of a single large radicle that rapidly descends to the moist subsoil and supplies water during the critical seedling stage."

When water is fairly plentiful during the growing season, the Indians use methods similar to those of the white man. In some localities the field is planted by using a pony plow to cut a slice eight inches wide and four or five in depth. Seed is dropped in every fifth furrow in hills about two steps apart and then covered by the next round of the plow. At Laguna and surrounding villages the fields are frequently barred off similar to the check rowing practiced in the corn belt; the hills are spaced about six feet apart throughout and with six or seven plants to the hill. The old method followed at Laguna provided for rows from seven to eight feet apart with the hills at intervals of four feet in the row, and from ten to fifteen plants to a hill.

In the past, ceremonies that were thought to bring increased yields were

held in connection with the planting, but today corn fields are seldom planted in this way. Edward Becenti, a Navajo of Kaĭchâske near Tohatchi, New Mexico, informed the writer that in former years the farmers of his tribe often began the planting in the middle of the patch. The first few hills were laid out in the form of a constellation of stars called *Dıl-yĕ-hi* (the Pleiades). The remaining hills of the field were then planted from this group in all directions. Another Navajo ceremonial farm, *dăăkĕ' nahasbâsi*, noted by the Franciscan Fathers at St. Michaels, Arizona, was planted in the form of a helix with the several rows wound sunwise. While the planter faced the east, the first hills were located in the center of the field, followed by others a step or two east, south, west, and north of the central hill in the order named. The second row was continued from the northern hill so as to encircle the five hills first planted, the men and women planting being careful to advance in succession, but never outside of the helical line once begun. The winding continued, increasing the periphery of each circle until the twelfth had been reached when the final hill was in an exact radial line with the eastern hill of the original five.

Soon after the corn germinates, the Pueblo Indian throws up earthen banks with the hoe or plow, dividing the field into small borders enclosing from three to six rows ten to sixteen hills in length. This division is very necessary to the economical use of water. In some of the southern villages water is applied soon after planting to hasten germination. Where the supply of water is limited, the corn is irrigated when the stalks are about one to two feet in height and again while tasseling. If water is plentiful, the Indian is apt to curtail his yield by over-irrigation. Flooding is the method usually followed in applying water, but the réal or furrow system is equally well known. In order to curtail the loss of moisture through baking and checking of the soil after irrigation, the Indian gives the field a rather crude cultivation before and after irrigation with a hoe fashioned from an old shovel. In some fields much of the labor of hoeing is eliminated by the use of the one-horse cultivator or the bull-tongue plow. Thinning is seldom practised by any of the Indians of this region as too many of the stalks are lost through cultivation, insects, and adverse weather conditions.

Agricultural implements of the natives of Laguna Pueblo. The hoes are fashioned from old shovels and provided with handles of piñon

Navajo corn fields receive but little attention after planting, although often three or four savage-looking scarecrows are left to defend the patches from the ravages of the crows. As the chief industry of the Navajo is herding his numerous flocks, he can spare little time for cultural operations in his corn. During the latter part of June a day is generally set for hoeing, and the family

The Heppatinna.—A Zuñi shrine in the midst of a large Indian cornfield. This structure is consecrated to the center of the earth over which spot it is supposed to stand

A Navajo's corn crop, Chin Lee, Arizona.—The Navajos cultivate an extensive area in the wash of the Rio de Chelly at the mouth of Cañon de Chelly and of Cañon de Muerto

carefully removes the weeds from the corn patches. If the herds are small and good grazing is obtainable near the permanent home, more care is given the fields and the corn is hoed first when about two feet in height and again when beginning to tassel.

The American hoe is now used almost universally, but the Franciscan Fathers state that in the early days two types of wooden implements were very common. The "eitherside" hoe (*a·tsā̆ji behē̆gŭdi*) was a straight hoe made by hewing down a piece of wood about a foot long to the thickness of one half inch, one end beveled on both sides, and a small hole provided at the center with a grip near the end. When in use, the hoe was grasped by the right hand so that the four fingers passed through the opening in the end and the thumb of the left hand through the smaller hole in the center. Taking a sitting position, the farmer scraped the hoe forward, cultivating within the radius of his reach. The "side-hoe" (*nābē̆hegŭdi*), also made of wood, was used in a standing position with a scythe-like motion. It consisted of a curved blade to which a wooden handle was secured with a thong of elk. The handle was grasped in the left hand while the thumb and forefinger of the right hand were passed through a thong attached to the back of the blade.

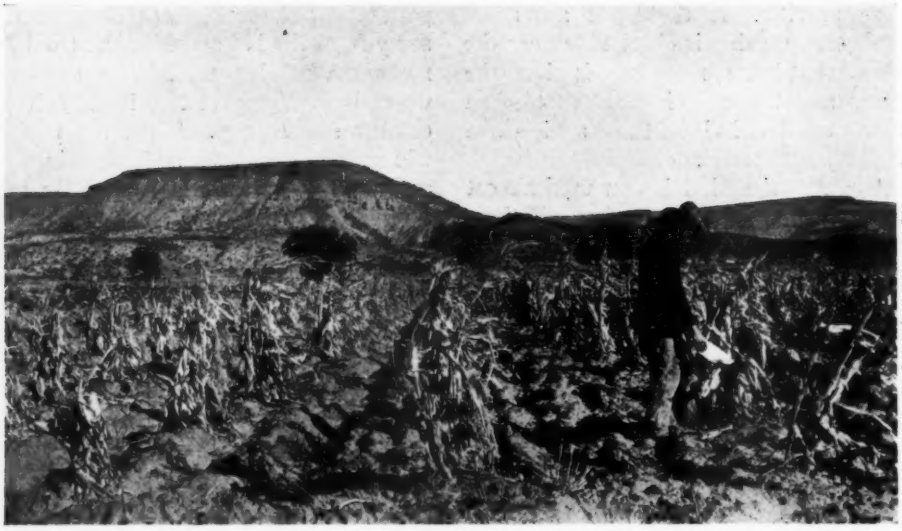
Unlike the Navajo, the Hopi must spend much of his time in the field. Very soon after planting he keeps a close watch on the hills to make sure that the first leaflets are not cut by the blowing sand or injured by the grub worms. Where the fields are subject to a wide sweep of the winds, often a hedge of brush is built on the windward side of the patch to stop the sands, and sometimes the farmer places a stone or small pile of sticks by the side of each hill for protection.

Although insect pests are found in every Indian's cornfield, the yields are not greatly affected by their depredations. The cutworm and wireworm cause some damage while the stalks are yet small, but the farmer pulls the sand away from the hill and kills the trouble-makers with his heel. The corn-ear worm is ever present and is difficult to combat successfully. Often the Indian will tear open the husk of the ripening ear and crush the worms found within between his horny thumb and forefinger.

The Pueblo Indians gather the ripened crop during the period from September 25 to October 15 after the melons and squash have been taken. The governor of the village decides the date for the

Hopi Indian of the First Mesa demonstrating his method of corn planting. Polacca, Arizona

corn harvest, and in the conservative pueblos, such as Santo Domingo, San Felipe, Tesuque, Taos, and Nambé, his proclamation is obeyed. In the more enlightened communities—Laguna, Acomita, and Isleta—the individual owner removes the corn from the field when he considers it mature. The ears are "slip-shucked" (snapped from the stalk with the inner husks remaining adherent to the ear) into sacking aprons and bags by the men and hauled to the village in



Laguna Indian husking corn into a sacking apron. This field was carefully cultivated and produced a good crop

Pima Granaries at Sacaton, Arizona.—Oat or wheat straw is woven into a coarse basketry in the form of a capacious chamber for the storage of corn and other grain. The walls and cap are fortified with adobe mud

Corn drying on the house tops at San Felipe Pueblo, New Mexico. When dry, the ears are carried below and stored

A Dooryard in Laguna.—The ears shown suspended by the husks were picked while "in the milk," and roasted, and are being dried in this manner for winter use. The dome-shaped structure in the background is the Pueblo oven, commonly used by the Indians and Mexicans in the Southwest

Field of Hopi corn and melons at the foot of the First Mesa, Polacca, Arizona. These crops were produced without irrigation

Exterior view of the Kiva of Sichumovi.—The kivas or estufas are underground rooms in which the secret fraternities hold their ceremonials. Note the corn piled about the entrance

wagons with sides enclosed by cornstalks and branches of cottonwood. At the village the ears are piled in the plaza in front of the owner's dwelling or in his yard.

The corn is husked clean by men, women, and children, a family often helping their relatives after the work on their own crop is completed. The ears are sorted as to quality into several grades or lots, and the corn of different colors is kept separate as far as practicable. After husking, the ordinary ears are spread to dry on the roofs or platforms constructed of cottonwood poles and branches. In pueblos like Laguna and Isleta, having houses surrounded by yards enclosed with adobe fences, the ears are dried on the hard packed earth. This is not practicable in villages with few fences, such as San Felipe and San Juan, as the hogs that run at large would soon devour the season's crop. When the corn has dried in the open air, it is taken into the house and stacked in the storeroom in piles like cordwood, sorted as to color and quality.

While the husking is in progress, each person lays aside for seed such ears as meet his approval, leaving three or four of the husks attached. After all of the corn has been husked, the head of the house makes long braids of the seed ears of each color by weaving the husks left adhering. The color varieties of corn grown by the several Pueblo groups include the red, blue, yellow, white, black, and many-colored or variegated corn; also pink, dark red, blue-spotted, gray, and blackcap. Red, blue, yellow, white and black soft, and sweet corns have been noted in the fields of the Navajos. The braids, often containing as much as one hundred pounds of ears, are dried in the open air and then suspended from the beams of the ceiling or swung over a rope or wire in the storeroom.

The standards followed in seed selection are purity of color, large ears, and early maturity, ears with large kernels having the preference over those possessing smaller grains. Seed is often held over to the second spring on the supposition that the older seed possesses greater vitality than new seed. In some pueblos the older generation objects to the importation of seed corn from other pueblos and villages, feeling that the corn of a community is such an intimate part of their life that it should not be mixed. But in other pueblos, men will be found who make special efforts to secure seed from distant sources, claiming that the imported seed grows better and larger corn.

The Navajos follow practically the same methods during the harvest as do the other Indians of the region. The ears are snapped or "slip-shucked" in the fields and hauled to the corrals to be husked clean and dried. The best ears are separated and saved whole for seed, no particular standard beyond size and color being set. A good large ear with all of the kernels of the same color or evenly spotted and mottled seems to be the Navajo's ideal in seed selection. A few people braid the seed ears, although most seed is simply sacked for preservation. As soon as the poorest ears are dry, they are thrown on a wagon sheet, a few at a time, and the grain shelled with a large stick or club. Grain shelled in this manner is used largely for horse feed or for sale. The sound ears not required for seed are hand-shelled and sacked, and if the family is living in a cabin or adobe house, the sacks of grain are piled in the storeroom for future use. When living in tents or hogans, the Navajos often store shelled corn in underground pits (*nûkï*) or caches. These pits are holes of various sizes dug in the ground in the shape of a wicker bottle, lined with the inner bark of the cedar, and the opening roofed with cedar poles laid close together and covered with sticks, slabs of rock, and dirt to complete concealment. In the pits the grain remains sweet and free from mold for a long time.

After the husking is completed, the stalks in the field are cut with sickles, hoes, or axes, and the fodder hauled to the village or permanent dwelling and stacked on platforms over the corrals to be fed to the horses during the winter. Many of the Pueblos bring the whole stalks to the yards of the village for husking, especially where the fields are some distance from the homes. Many uses are found for the husks: for cigarettes, as binding material for the various ceremonial objects of the dances, and in much of the basketry. The Navajo frequently mixes the husks with mud and employs the plaster thus made in covering the walls and roof of his hogan. Cobs are used as fire lighters and as fuel when wood is hard to obtain.

Grain standing in the field and the ears retained for seed belong to the man, but as soon as the ears are husked, the ownership passes to the woman, who uses or sells the grain as she sees fit. She allows her husband such corn as he needs for his horses, but he must secure her permission before he can sell any or make presents of corn to strangers or needy persons. This custom is observed by the members of practically all of the tribes in the region.

Corn enters into the composition of so large a number of foods that a complete inventory of Indian cookery would be a difficult task. Mr. Walter Hough enumerates fifteen kinds of paper bread, three kinds of mush, five of shortcake, eleven of boiled corn, four kinds baked or roasted in the coals, two cooked by frying, four stewed, and eight of cooked shelled corn, making a total of fifty-two prepared by the Hopis alone. When one considers the great diversity of the corn preparations devised by the Indian as compared with our own few dishes, he readily sees that the white American has much to learn with regard to the use of this valuable cereal.

Courtesy of the U. S. National Museum

Hopi Bread Makers.—The two maidens, characterized by the dressing of the hair in whorls, are engaged in reducing to meal the ears of corn in the basket. The married woman in the corner mixes the meal with water and wood ashes, giving it a gray color, and whips the mixture to a thin batter. Her companion spreads the batter on the baking stone with a dexterous sweep of her hand. After baking a few moments, the *piki*, or "paper" bread, is removed and piled on the floor to dry. One writer has aptly said that in appearance it resembles "the material of a hornet's nest"

CONTRASTED METHODS OF TEACHING GEOGRAPHY

EVER since the remote days when Hecatæus of Miletus wrote his *Periodos* and thereby earned for himself the title of father of geography, the science that has to do with the phenomena of the earth's surface has proved a fascinating pursuit to mankind. When the blight of the Middle Ages fell upon scientific inquiry in Europe, the Arabs kept alive the spirit of learning, and among the translations that appeared in Arabic were the works of Ptolemy. With the coming of the Renaissance, geography re-emerged to take advantage of all that the era of discovery had to offer.

Geography links itself with many different interests. Its subdivisions, including mathematical, physical, political, historical, and commercial geography, indicate how many are its points of contact. It must accordingly hold an important place in any scheme of education.

The textbooks of half a century ago for the most part taught geography by rote. We open a typical geography of that period and on the first page encounter the following:

1. What is Geography?
   Ans. A description of the surface of the Earth.
2. What is the surface of the earth?
   Ans. It is the outside part.
3. How is the surface of the Earth divided?
   Ans. Into land and water.
4. How much of the earth's surface is land?
   Ans. About one-fourth.

Our eye glances down a subsequent page and stops at the question:

18. How is the Ocean divided?
    Ans. Into five great parts, likewise called Oceans.
19. Which are the five Oceans?
    Ans. They are the Northern, Southern, Atlantic, Pacific, and Indian Oceans.
20. What other names have some of the Oceans?
    Ans. The Northern is often called the Arctic, and the Southern, the Antarctic, and the Pacific Ocean is sometimes called the South Sea.
21. Into what other parts is the water divided?
    Ans. Into Seas, Archipelagoes, Bays, Gulfs, Sounds, Straits, Channels, Lakes, and Rivers.
21. What is a sea?

And so on through page after page.

The function of textbooks of this character was to hammer facts into often unreceptive crania. They did little to dispel the illusion that study is necessarily a task. They made slight attempt to engage the interest of the pupil; they asked questions instead of stimulating him to ask them. It is true that the conscientious pupil carried away with him an equipment of facts, but they were often facts that had sunk into his head because of their dead weight and not because their vividness flashed an ineffaceable picture on his mental vision.

The one advantage that can be claimed for the old-time methods is that the pupil acquired a more definite knowledge of the location of places and the boundaries and relations of countries to one another than he does under the more interesting methods of today.

A sharp departure from geographies of the old type is one entitled *Human Geography* by J. Russell Smith.[1] The child picking up this book will be fascinated by its story interest. Facts are not conveyed to him as disassociated frag-

[1] Professor Smith, who holds the chair of economic geography at Columbia University, has divided his *Human Geography* into two parts, which will be published successively by the Winston Co. of Philadelphia. Book I, entitled "Peoples and Countries," now in readiness, is to be followed at some time in the future by Book II, entitled "Regions and Trade."

ments but in a flowing narrative that brings before his eyes people and animals and plants from widely separated parts of the globe. The concrete replaces the abstract. The child is made to think rather than merely to memorize. Incidentally, be it said, for the illustrations that add interest to the pages of the book the author has drawn to some extent upon natural history material in the possession of the American Museum.

How little a map really means to a child! It is a mere symbol, without any clue to the physical features of the regions represented. The colored areas conjure up no picture. The Arctic snows may be represented by the same shade of pink as the verdure of the tropics. Dr. Smith makes us realize that there are distinctions. He invites his reader to step aboard an automobile at a designated place on the east coast and then heads for a destination on the west coast. You journey through the plains, cross rivers, climb mountains, traverse deserts. You see the changing country as you go. And after that, when you are asked to retrace the trip on the map, you supply what the map fails to reveal.

The author never neglects to keep within the range of comprehension of the pupil, moving always from the familiar to the less familiar. Perhaps the contrast between the two methods of teaching cannot be indicated more effectively than by printing below on the left of this page a citation from the textbook of fifty or more years ago, which attempts by question and answer to define latitude, and in juxtaposition to it on the right of the page Dr. Smith's way of stating the same thing.

---

130. What is latitude?
A. It is distance from the Equator either north or south.

131. How is latitude divided?
A. Into north and south latitude. All countries situated north of the Equator, are in north latitude and those south of it, are in south latitude.

132. How is latitude represented on maps?
A. By lines drawn across the map from side to side. These are called parallels.

133. How is latitude numbered?
A. The numbers are marked on the sides of the map, at the ends of the lines of latitude.

134. How is latitude counted?
A. In degrees from the Equator toward the poles, from 1 to 90.

135. How can you distinguish be-

LATITUDE, LONGITUDE AND ZONES

31. **Telling Where Places Are.**—How do we tell someone where a house is located in a city? First we need a starting point of some kind. In the city of Washington this starting point is furnished by two streets which cross each other, one going east and west, and the other going north and south.

Name these streets. All that part of the city north of East Capitol Street and east of North Capitol Street is called the Northeast. The streets with number names run parallel to North Capitol, and the streets with letter names run parallel to East Capitol. The houses

tween north and south latitude?
A. If the numbers increase from the bottom toward the top of the Map, it is North Latitude; but if they increase from the top to the bottom, it is South Latitude.

136. On Map of the World, No. 1, Eastern Hemisphere. In what latitude is Europe?
A. N. Le.

137. In what latitude is Australia?
A. S. Le.

138. In what latitude is Africa?
A. Partly in N. and partly in S. Le.

139. In what latitude is Asia?
A. N. Le.

140. On the Western Hemisphere. In what latitude is North America?
A. N. Le.

141. In what latitude is South America?
A. N. Le. and S. Le.

142. What latitude have places on the Equator?
A. They have no latitude, for latitude begins on the Equator.

143. What is the latitude at the Poles.
A. It is 90 degrees, which is the full extent to which latitude is carried.

144. What is the meaning of the word latitude?
A. It means breadth; it was applied long ago to distances north and south, because the world was supposed to be much less in extent in that direction than from east to west.

145. Do the degrees of latitude vary in length?
A. They are nearly all alike, being about $69\frac{1}{4}$ miles each.

In consequence of the earth's being flattened at the poles, the degrees of latitude increase slightly in extent in going either north or south; but $69\frac{1}{4}$ miles is a fair average of their extent.

in the block from East Capitol Street to A Street have numbers below 100, those between A and B Streets have numbers beginning with 100, and so on, each block beginning with a new hundred. The same thing is true of the house numbers on the streets with letter names. Therefore a house numbered 220 Third Street, N.E., must be on Third Street between B and C. Thus we can locate a house in Washington by number, street, and section.

In much the same way we locate a city, a lake, or a river, that is, by giving its distance north or south from the equator and its distance east or west of some particular place.

32. **Latitude.**—If you look at the map you will see some lines running across the map. All parts of each line are the same distance from the equator. These are called *parallels* and are used as a means of telling how far a place is north or south of the equator. The distance from the equator to the North Pole or from the equator to the South Pole is divided into ninety equal parts, and each part is called a degree of latitude. A degree of latitude equals about seventy miles. Each parallel on the map marks a certain degree of latitude, or distance from the equator. Twenty degrees north latitude means twenty degrees north of the equator. Twenty degrees south latitude means twenty degrees south of the equator. How many miles north or south would that be?

Photograph by C. L. Dewey

CARL E. AKELEY

Sculptor, inventor, big game hunter, and explorer, photographed as he departed on his fourth expedition to Africa

CARL E. AKELEY AGAIN PENETRATES THE AFRICAN JUNGLE

THE VETERAN HUNTER OF BIG GAME, WHO VISIONED AND PLANNED THE PROPOSED ROOSEVELT AFRICAN HALL OF THE AMERICAN MUSEUM, IS STUDYING AND HUNTING THE GORILLA IN ITS NATIVE WILDS

BY

DOROTHY S. GREENE

IT IS only a few months since the country was surfeited with novels and plays which, though widely varied in plot, always reached the same terminus,—"And then came the War." The world of fiction, quick to sense the public's first irritation and fatigue, has shifted once more to scenes of normalcy and peace time. Unfortunately, however, it takes more than imagination, pen, and paper to replace the interrupted achievements of the world of reality on a pre-war basis. Many undertakings which were making long strides toward completion in 1914, today stand arrested by the force of circumstance, and only one by one can they fall back to their natural places in the march of progress. The more urgent must be given place first.

In 1914, Mr. Carl E. Akeley had laid before President Henry Fairfield Osborn and the Trustees of the American Museum his plan for a great African Hall which should give a comprehensive picture of the African fauna. Years of hunting and exploration in Africa, of modeling the wild animals as he saw them in the jungle, and of perfecting the art of taxidermy, made him the one man for whom such a conception was possible. The Trustees appreciated the opportunity and the plan had been immediately approved for execution as far as funds might be available. That work might be begun on the habitat groups intended for the new hall and that men might be trained to carry on the work, one of the old North American mammal halls, rechristened the "elephant studio," because Mr. Akeley had been engaged in mounting a group of elephants there since his return from Africa in 1911, was retained for his use. Here, to make his conception more concrete, Mr. Akeley had completed a model of the future African Hall.

This model represented a great unobstructed hall, 60 x 116 feet, in the center of which stood a statuesque group of four African elephants, flanked at one end by a group of black rhinos, at the other by a similar group of white rhinos. Both on the ground floor and in the gallery, with windows seeming to open upon them, were arranged habitat groups, of the African fauna with typical accessories and panoramic backgrounds. The long and arduous task of mounting the central elephant group had been begun but was interrupted when Mr. Akeley left his usual pursuits to add the service stripes of the Army to the service stripes of the jungle.

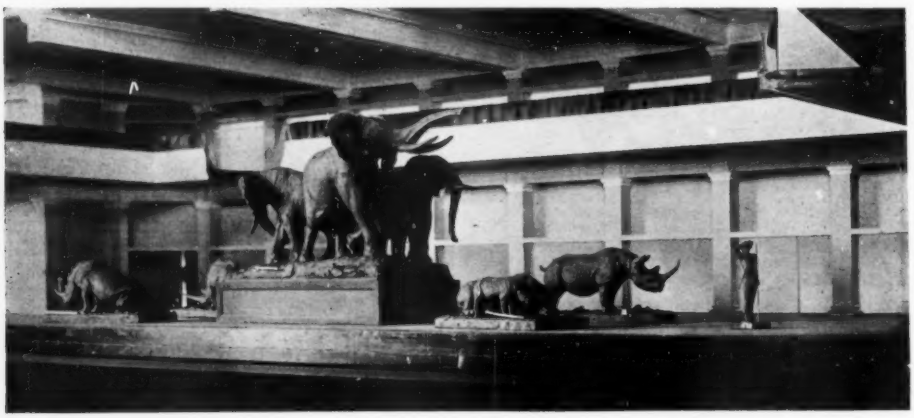
Now or never the African Hall must become a reality. Twenty-five years ago with innumerable specimens at hand, its development would have been an impossibility because methods of museum exhibition were far too crude. Twenty-five years hence it will be equally impossible. The inroads of modern civilization are bringing the Age of Mammals to a close in Africa, its last stronghold, and unless specimens for mounting are secured at once, they never will be.

It is for this reason that the expedition into the gorilla country which Mr. Akeley has just begun is of such immediate importance. Because of many characteristics similar to those of the human race, the gorilla is of especial interest for scientific research and for

exhibition purposes, and this particular species of ape, always scarce and limited to a comparatively small area, is rapidly becoming extinct. If Mr. Akeley is able to secure specimens from which the life history of the gorilla can be studied and told in scientific records and in a habitat group, he will have performed another great service for science.

Entering Africa from Cape Town, Mr. Akeley and his party will travel west and north over three thousand miles into the Kivu country, the home of the gorillas. Although a very devious route, this long journey by rail through Bulawayo, Victoria Falls, and Katanga, by boat along the Lualaba River and into Lake Tanganyika, will be most advantageous in that it affords an opportunity for a general survey of South Africa and for the collection of data invaluable in the planning of the African Hall. An exact and detailed knowledge of African life in all phases is required for the execution of animal groups and also for the series of bas-relief panels in bronze which will be placed in a frieze above the floor groups and along the balcony to illustrate the life of the native tribes of Africa in their relations with wild and domestic animals. With the aid of a motion picture camera, which Mr. Akeley has designed especially for his work in the field and which facilitates wild animal photography, because it can be operated noiselessly and in dark places, he will be able to add greatly to the fund of information gathered on three previous African expeditions.

The Roosevelt African Hall,—for naturally and appropriately, since the death of the Trustee of the American Museum who was most interested in the preparation of African exhibits and who had himself shot one of the elephants for the central group, the proposed plan has come to be known as the Roosevelt African Hall,—is a project which will put in permanent and artistic form a complete record of fast disappearing animal life and give a comprehensive view of the topography of Africa. It is a project which will exemplify the life work of Mr. Akeley who combines the genius of the sculptor with the courage of the explorer and who has created an art which he still modestly calls "taxidermy." If this project can now be pushed forward as before the War and finally completed, the American Museum of Natural History will have set the standard for museum exhibitions of the future.



A model of the projected Roosevelt African Hall. The splendid elephant group flanked by rhinos illustrates Mr. Akeley's marvelous gift of representing the lifelike pose, the dash and ferocity of the creature of the jungle

"TERRITORY IN BIRD LIFE": A REVIEW[1]

MR. H. ELIOT HOWARD, who is already well known for his detailed studies on the life histories of the British warblers, has been devoting years of patient research and observation to an interpretation of many of the more obscure activities of common birds during that most important cycle in the events of the year—the period of reproduction. The result—proving conclusively that a painstaking worker with an original mind can take a seemingly well-worn subject and upon it cast new light—is a stimulating book in a much neglected field, the forerunner, let us hope, of many others.

It has long been conceded that during the breeding season a given pair of birds will assume rights over a certain territory and will drive away others of their kind. This holds true even when the species is highly gregarious during the winter. In contrast to these are other species of birds even more gregarious during the breeding season than during the winter, nesting in such densely packed colonies that the human observer is amazed that the individual can find its egg among so many thousands.

Such facts in the life histories of the common British birds are familiar for every species; nor does Mr. Howard claim to add anything to our knowledge of any particular species. What he does is to advance a theory, founded on careful observation, which accounts not only for the differences in the life histories of any two species, but also for any radical change of habit in a species at various seasons of the year. In his view "territory" is the key to successful reproduction. The chaffinch wanders in flocks over the country during the winter, a highly gregarious bird. Should this flock nest in a colony, the competition for food would be infinitely more severe, the parents would be forced to go farther afield in search of food, and the delicate young, which require constant brooding, during an absence of the parent might be fatally exposed to heat, cold, or rain. Consequently, the male, the first to feel the sexual impulse, leaves the flock late in winter, selects a territory where he is found almost continuously, and advertises his presence by his song, which begins at this time. He drives off other males and invites each female to remain until at length he secures a mate. The size of the territory which a species selects is in direct relation to the type of food which it requires and the abundance of that food. An acre is ample for a chaffinch; a few hundred yards along a river bank provides a kingfisher with sufficient minnows and shiners for his family; but a peregrine falcon requires many square miles of barren moor to insure an adequate supply of grouse and hares.

The guillemot is a good illustration of a colonial nesting species. Its habit of nesting on the ledges of cliffs well-nigh eliminates enemies which might destroy the young. Because such cliffs are few, every foot of available space must be utilized. A corollary is that the male requires no song to attract the female—she can only repair to the same cliff; hence, the species is practically voiceless. The young are not delicate or helpless at birth. They require but little brooding, do not have to be fed often, and the parents, therefore, have plenty of time to scatter over the neighboring ocean where there is an inexhaustible supply of food. There is no need, then, for a greater territory than a few square feet; in fact, should each pair appropriate an area twice as large, the number of breeding pairs of guillemots about Great Britain would be reduced by half.

It remains to add that the book is favorably printed, and the plates, depicting the combats of various species in defense of their territory, are by two artists of eminence and are up to their usual standard.

LUDLOW GRISCOM.

[1] *Territory in Bird Life.* By H. Eliot Howard. With illustrations by G. E. Lodge and H. Grönwold. 8vo. pp. 301. New York, 1920. E. P. Dutton & Co.

NOTES

As NATURAL HISTORY goes to press announcement comes of the death on August 29, near Cornwall-on-Hudson, of the revered Honorary Curator of the Department of Mammalogy, Dr. Joel Asaph Allen, whose term of service in the American Museum, dating from May 1, 1885, exceeded in length that of any member of the present scientific staff.

To his keen intellectual application and unstinting devotion of time and effort are due in no small measure the prestige enjoyed by the departments of mammalogy and ornithology, which, at the time Dr. Allen joined the Museum and for many years thereafter, were embraced in a single department.

Up to the very end and notwithstanding severe strains on a physique none too strong, his virile mind retained its interest in natural things. In addition to his ardent work at the Museum, which included not only the responsibilities of his curatorship but also for many years the editorship of the scientific publications, he was for seven successive years (1883-90) the President of The American Ornithologists' Union, the founding of which in 1883 was due in part to his instigation. For twenty-seven years he was the editor of *The Auk*, the journal of this organization. He served for several years as Vice President of the New York Academy of Sciences and for a number of years as President of the Linnæan Society of New York.

Dr. Allen was a prodigiously prolific writer. A few years ago he compiled his bibliography, and the list of his writings, exclusive of hundreds of minor reviews and many unsigned editorial paragraphs, embraced more than 1400 titles.

At a meeting of the faculty of the American Museum, held on August 29, the following Resolution was adopted:

Resolved, That the members of the faculty of the American Museum of Natural History, learn with profound regret and sorrow of the death of their associate, Dr. Joel Asaph Allen, and wish to give expression to the affectionate regard which they had for him as a man, and of the high esteem in which he was held as a scientific associate. Coming to the Museum in the early period of its history as a research institution, for thirty-seven years Dr. Allen gave himself devotedly to his labors as curator and editor, rendering to the Museum and to science service of lasting and inestimable value.

SINCE the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum:

Annual Members: MRS. J. H. BURTON; MISS VELMA L. LILLIE; DOCTOR JOSEPH B. WEIGHART; CAPTAIN CHARLES W. HALSEY; MESSRS. GEORGE R. M. EWING, ALAQUAH FLOOD, B. B. GIRDEN, A. AUGUSTUS HEALY, AND WALTER PELS.

Associate Members: MESDAMES P. P. BEALS, EDITHA S. CAMPBELL; the MISSES MATEAL ALLEN, ORPHA LORENA APP, LYDIA M. LA BOITEAUX, MARGARET JANE SCHMIDT, LEE VAN ROSSUN; DOCTORS LEON ASHLEY PEEK, M. W. STREALY, LILIAN WELSH; MESSRS. FREDERICK D. AMES, ORIN S. BACON, JR., JOHN T. BAKER, ED. T. BARDEN, JAMES D. BLACK, ROBERT LARNED BLACKINTON, W. L. BUCKLAND, E. T. CRESSON, JR., CLIFFORD CRONK, GROSVENOR ELY, CHARLES F. FLORY, J. HASE MOWREY, EMORY W. THURSTON, LOUIS WEBER, and E. R. WOLCOTT.

PRESIDENT HENRY FAIRFIELD OSBORN has recently received the following letters,—the one from Petrograd, informing him of his election to honorary membership in the Société Paléontologique de Russie, the other from Bologna, telling him of his election as a corresponding member of the Royal Accademia delle Scienze dell' Istituto di Bologna, Classe di Scienze Fisiche:

"It is with great satisfaction that I inform you, that the Russian Palæontological Society, founded in 1916, has elected you as honorary member on February 18, 1921.

I remain respectfully yours,
NICHOLAS YAKOVLEV.
President of the Society."

"The Section of Physical Sciences of this Royal Academy joins in testifying to the high and general esteem which you, illustrious Professor, have earned with your learning and your love for the development and advancement of the Sciences, and has, by unanimous vote, taken at the special meeting of the 17th instant, adorned its roster of Corresponding Members with your name.

Accept the official attestation of this act, which the Section extends to you through us in the attached diploma which we have the honor to send you with the desire and hope of receiving your frequent and learned communications.

On this first and appreciated occasion, we have pleasure in extending to you our greatest respect.

The Secretary, ERCOLE GIAISMINI — The President, G. RUGGI."

ONE of the most important desiderata of the American Museum, a specimen of the African shoebill stork, has been supplied through the courtesy and energy of Mr. Irving K. Taylor, who obtained a specimen during his visit to the Sudan district, Africa, in 1920-21.

This is the first specimen of this bird to reach the Museum and probably the only others in the United States are the four secured by the Roosevelt Expedition. The bird is confined to a limited part of the Sudan and Congo region, is

quite rare, and is protected in the greater part of its habitat. We hope to give an illustration of this specimen as soon as it is mounted. It is a bird of somewhat doubtful affinities, being considered by some as a stork-like heron and by others as a heron-like stork, the authorities finally compromising by assigning the bird to a family of its own.

In addition to the shoebill, Mr. Taylor secured for the Museum a much desired series of skulls of the African crocodile, including one remarkably fine and large specimen. This should have come from a creature at least 15 feet long, but it is a well-known fact that the largest animals shrink before a tape line or a two foot rule, and unfortunately Mr. Taylor measured this specimen and records its length as 13 feet 10 inches, which is still a pretty good size for a crocodile. The teeth of this species are unusually sharp and strong and the jaws remarkably powerful; looking at them one can appreciate Mr. James P. Chapin's statement that the danger to human beings from the man-eating sharks amounts to nothing in comparison with the destruction of man and other animals by African crocodiles.

THE American Museum possesses a remarkable collection of fossil crocodiles and alligators, accumulated during the western explorations of the last thirty years. During the past few months Dr. C. C. Mook has published, preparatory to describing the fossil forms, a series of articles in the American Museum *Bulletin*, dealing chiefly with existing crocodilians. These are the first fruits of his researches on this rather neglected group of reptiles, which played a more important part in the life of former geologic times than it does today. The crocodiles, the broad-headed alligators and caymans, and the slender-snouted, fish-eating gavials are the surviving remnants of a once numerous group, which inhabited the rivers and seas of all parts of the world.

In attempting to clear up the relationships of the extinct species, Doctor Mook soon found that the skeleton characters and relationships of the existing species were very imperfectly known, and he had to study the modern forms before he could clear up the affinities existing between the extinct species. Through the courtesy of the National Museum, the Museum of Comparative Zoölogy, the University of Michigan, and other institutions, he was able to get together almost every species of modern crocodilian and to obtain a clear idea of their relationship.

The second portion of the research will deal with the evolution and geological history of the crocodiles of the Tertiary Period (Age of Mammals), especially of the American species. Crocodiles were quite common in the Eocene formations of Wyoming, and alligators are found in the Oligocene and Miocene of South Dakota and Nebraska. No careful study has been given, however, to the fossil species, and their relations to the Tertiary crocodilians of Europe and elsewhere has not been cleared up. This portion of the research is but partly accomplished as yet and is to be followed by a study of the more ancient crocodiles of the Mesozoic (Age of Reptiles), as represented in the American formations. The Mesozoic crocodiles were much more numerous and varied, including several marine groups. Besides the gavial-like kinds with long, slender snout there were several river and shore-dwelling crocodiles of large size and with heavy, broad skulls, and other swift, sea-going kinds with forked tail and little or no bony armor. Many fine skeletons of these are to be seen in European museums; but much less is known about the American crocodiles of the Age of Reptiles.

THE interesting article on "Snakes that Inflate," contributed by Mr. G. Kingsley Noble to the March-April issue of NATURAL HISTORY (pp. 166-171), has come to the attention of a correspondent at the Crow Agency, Montana, who comments on the fact that a terrorizing attitude of the character described by Mr. Noble is assumed also by the bull snake. "For the past forty years," says this observer, "I have seen these snakes that had fled our sight, but this summer one was found coiled in a path and hissing like a gander. On closer approach it struck and at intervals repeated it. I teased the snake to ascertain the length it could strike and never did that length exceed eighteen inches and generally it was about a foot. At each intake of air about half its body was considerably distended. This was all a bluff intended to terrify a possible enemy. Teasing failed to move the snake, so I passed on." The reference to the bull snake's "hissing like a gander" recalls the fact that this habit has earned the snake, in some parts of the country at least, the designation of "goose snake."

Upon receipt of the letter from the Crow Agency, Mr. Noble dissected one of the bull snakes, preserved in alcohol, in the collection of the American Museum. He found the dorsal membrane of the trachea not distensible or specialized for inflation as in the case of the species discussed by him in the article. The inflation which the correspondent records must, therefore, have been due to the filling of the lung with air and would necessarily have been less formidable than in the other species mentioned.

THROUGH the courtesy of Mr. F. H. Haines the American Museum's department of entomology, which includes in its scope the spiders as well as the insects, has recently obtained several live specimens of the water spider (*Argyroneta aquatica*). Although this spider is

an air-breathing creature, it spends practically all of its existence in the water. It is able to breathe beneath the surface by virtue of a bubble of air, bright as a globule of quicksilver, which is retained in the long hairs that cover the spider's abdomen.

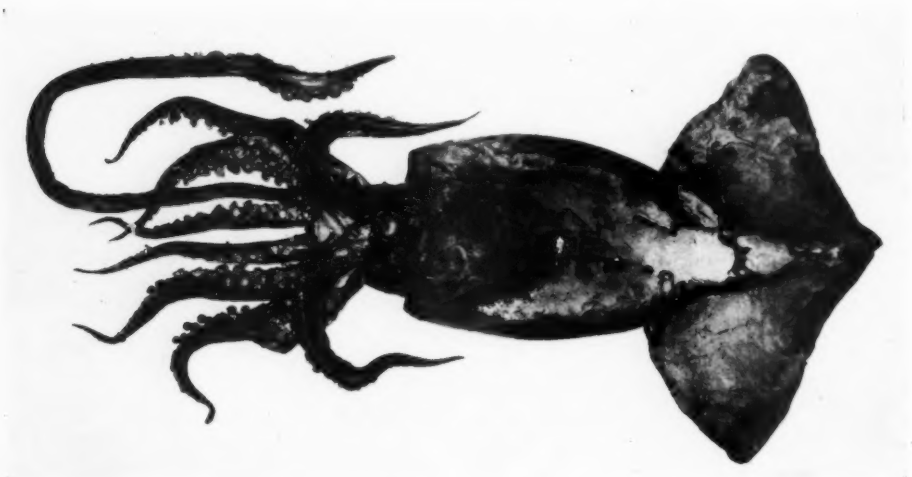
The nest-building operations of this spider are most interesting. It fashions a closely woven, silken dome on a water plant some distance below the surface and thereupon proceeds to fill this structure with air. For this purpose the spider rises in the water, raises its abdomen above the surface, and then quickly submerges it again to carry below the precious air bubble imprisoned in the hairs. When it reaches the silken dome, it releases within it the captive bubble, and by repeating the operation, gradually creates a little air-filled tent in which it takes its rest. It has been stated that the young of this species save themselves the trouble of nest-construction by utilizing the empty shells of water snails, which they float by filling with air

The genus *Argyroneta* has but a single species, which is distributed throughout Europe and North and Central Asia. In the Old World it is often seen in aquaria; the specimens sent to the American Museum have been placed in a cylindrical glass bowl for observation.

MR. JAMES P. CHAPIN, assistant curator of African birds in the American Museum, sailed for Europe on August 18 for the purpose of rounding out his studies of the birds of the Congo, preparatory to issuing a *Bulletin* on this subject. He will go first to Berlin, where he will come in touch with Dr. Anton Reichenow and Dr. Erwin Stresemann, and later to Munich to consult with Dr. C. E. Hellmayr. Other continental places included in his itinerary are Vienna, Marseilles, Paris, and Brussels. On November 9 he will be the guest of the British Ornithological Club at London, where he will probably deliver an address on the Congo birds. He will return to America toward the end of November.

THOUGH interesting stories of prowess and resource might be related in connection with the acquisition of many of the specimens in the American Museum of Natural History, it is not often that a creature is obtained in so unexpected and unusual a way as the rare species of squid, *Sthenoteuthis pteropus*, which recently reached the Museum. Apparently recorded only twice before, the last previous capture dating back to 1876, this curious animal, which because of its interest and rarity would have justified a painstaking search on the part of the student of marine life, was accommodatingly washed aboard a large ocean liner during a heavy storm. To Captain George Biggle of the S. S. "Caronia" of the Cunard Line the Museum is indebted for this valued donation.

It was when the "Caronia" was a day's sail out of Queenstown and approximately in latitude 51°30′ north, longitude 15° west, that it received this strange visitor, whose presence must surely have created considerable commotion on shipboard even if one accepts with caution the perfervid accounts of its capture which appeared at the time in certain newspapers. One journal, not to minimize the impressiveness of the creature, assigned it a length of fifteen feet. The actual size is remarkable enough without resort to fantastic exaggeration. From the tip of its tail to the end of its tentacular arms, the animal



This rare squid, a formidable monster of the ocean, was washed aboard a trans-Atlantic liner during a storm, creating no little excitement on shipboard. It is today preserved in the collections of the American Museum

measured 159.5 cm., or about 5 feet—by far the largest specimen of its species thus far reported.

Equipped in life with eight tentacles of approximately equal length and two long tentacular arms, it must indeed have been a formidable antagonist. The tentacles are armed with rows of pneumatic suckers, cylindrical in shape, on the inner surface of which is a ring of horn bearing denticles, or serrations, that by sinking into the prey reënforce the action of the suckers. The tentacles are grasping organs conveniently surrounding the mouth, which is provided with a parrot-like bill of horn. It is with this sharp instrument that the actual work of destruction is done. The small more or less round area below the tentacles that in the full-length picture on page 434 is conspicuous by its brightness is the siphon, which is an organ of propulsion, enabling the creature by the intake and subsequent ejection of water to swim through the sea, the protruded siphon being curved backward and the water expelled in that direction if forward progress is desired and vice versa if a retreat is contemplated.

The specimen taken in 1876 was captured off the north coast of Bermuda. Squids are more commonly associated, however, with the North Atlantic than with subtropical waters. The giant squid, another genus of the same family to which the species under consideration belongs, has been found off the Banks of Newfoundland engaged in battle with sperm whales. The common squid, *Loligo pealii*, is abundant along the North Atlantic coast, where it is largely used by fishermen for bait. Among the Japanese a kindred species is used as food. A Mediterranean species, *Sepia officinalis*, is the form from which the sepia of commerce is derived. All of these, as contrasted with *Sthenoteuthis pteropus* and with the giant squid, are of relatively small size, varying from one to two feet in length.

An article containing a more detailed description of *Sthenoteuthis pteropus*, is being prepared for issue in the *Bulletin* of the American Museum by Mr. Roy W. Miner, associate curator of lower invertebrates. Under the direction of Mr. Miner work is about to begin on a model of this squid, which will be placed on exhibit during the coming year. Data have been gathered and sketches made for the purpose.

The mouth of the squid is surrounded by tentacles that, grasping out for prey, supply it with food. The dark object protruding from the mouth is the bill of horn with which the creature destroys its capture

THE work of the department of public education, American Museum of Natural History, is showing a gratifying growth. There was an increase in all activities during 1920 and the present year gives every indication of even more substantial accomplishment. Mrs. Ruth Crosby Noble, assistant curator, who is in charge of the work among the blind, had fifty-seven classes up to June, 1921, as against fifty classes during the entire previous year. The lantern slide distribution, in charge of Mrs. Grace Fisher Ramsey, assistant, totalled 106,000 slides for the first five months of the present year. The number of slide borrowers for six months of 1921 was 1000; for twelve months of 1920, 1700.

DR. WILLIAM K. GREGORY, curator of comparative anatomy in the American Museum, has been received with great cordiality by the scientific circles of Australia, which continent he is visiting with the twofold purpose of arranging for exchanges of specimens and of collecting in the field. He writes with appreciation of the hospitality accorded him at the Australian Museum in Sydney and particularly of the kindness shown by Dr. T. S. Dixon, its president; by Dr. Charles Anderson, its director; by Mr. Charles Hedley, who "has been our general adviser and constant friend"; and by other members of the staff.

Dr. Gregory has been much impressed by the many unique and priceless specimens on exhibition at the museum. There is a remarkably well preserved skull and jaw of a primitive squalodont (an extinct whale) from Tasmania, which awaits scientific description. An excellent cast of this skull and jaw has been promised to the American Museum. The aboriginal human skeletons, some of them representing unusual phases of dentition, were of particular interest to Dr. Gregory, and he speaks enthusiastically, too, of the splendid collections of fish, reptile, and mammal skeletons.

As a preliminary to his contemplated collecting trip Dr. Gregory took a jaunt with Prof. L. Harrison, of the local university, and "in a little while," he writes, "we collected cystigna-

thid and hylid frogs, nearly limbless skinks, and saw the tracks of arboreal marsupials."

Dr. Gregory's collecting trip is a timely undertaking. A delay of a few years would have been costly, for the native Australian fauna, one of the most interesting in the world, is rapidly disappearing, due in part to the unequal combat it is waging against such introduced creatures as the rabbit, fox, rat, and dingo, in part—it is the more serious part—to the ruthless destruction of the fur hunter. That Australia is awakening to the seriousness of these devastating agencies is gratifying; it would seem excess of zeal, however, to apply restrictions to the collecting for museums, a movement that has recently been agitated. All the Australian mammals in all the museums in the world are but a drop in the bucket compared with those disposed of at a single sale held in St. Louis, the great fur market of the United States, in February, 1920, on which occasion no less than 500,000 Australian opossum skins were sold. A few months later in the same year a lot of 400,000 was placed on sale in the same city, which, with London, New York, and to a smaller extent Toronto, is largely responsible for the recent grand-scale destruction of mammalian life that has taken place. It has been calculated from a compilation of the fur sales in these and other centers of distribution that in 1919 no less than 1,133,917 skins of the smaller Australian marsupials were sold throughout the world. In 1920 the figure rose to 2,070,349, and for the first six months of the present year the sales had exceeded 775,000 skins.

IT is probably seldom realized by the wearers of costly furs what an appalling destruction of wild creatures is involved in the manufacture of such apparel. According to an article contributed by Dr. William T. Hornaday to the March issue of the *Zoölogical Society Bulletin* no less than 80 skins are required on the average for the making of a mink wrap, 200 skins for a squirrel coat, 280 to 300 for a black mole coat. A Siberian ermine wrap may contain 300 skins, a striped skunk jacket 90 skins.

Dr. Hornaday believes that this wild orgy of slaughter, if maintained, is destined in a very few years to wipe out the interesting mammalian life of the globe. Far regions are being scoured for creatures that a little while ago would not have been considered marketable, but which today, with the growing scarcity, command a price. Even the domestic cat is requisitioned and under the euphemistic designation of "genet" ekes out a rapidly dwindling supply of pelts. A few years hence, if the slaughter keeps up, there may be no more fur-bearing creatures and incidentally no more furs.

NATURAL HISTORY welcomes the appearance of the first number of *The Australian Museum Magazine*. This museum, located at Sydney, was incorporated as long ago as 1853 and prior to that time had its affairs administered by a committee. It has zoölogical, palæontological, ethnological, and mineralogical exhibits, with especial emphasis in each of these groups on Australian representatives, not to mention historical and numismatical sections of more limited extent. Prior to the appearance of the magazine the publications of this museum were confined to reports, memoirs, records, and catalogues, intended primarily for specialists in the various branches of natural science. The purpose of the magazine is to reach the general reader and to familiarize him through non-technical articles with the different divisions of natural history. In this connection, the collections of the museum will receive the emphasis to which they are entitled. One of the features contemplated by the editor, is a series of articles describing the best methods of collecting and preserving animals, and of recording observations on animal life.

A number of changes have recently been made in the scientific staff of the Australian Museum. Dr. C. Anderson, M. A., who has been mineralogist since 1901, succeeds in office the late Director Etheridge. Mr. A. Musgrave fills the vacancy caused by the death of Mr. W. J. Rainbow, entomologist, and Messrs. J. R. Kinghorn and E. le G. Troughton, second-class assistants, have been promoted to be first-class assistants, the one in charge of reptiles, birds, and amphibians, the other of mammals and skeletons.

IN CONNECTION with the article by Mr. Charles W. Mead, entitled "Indian Corn or Maize" (p. 409 of this issue) it may be well to refer to the widespread belief, founded on published statements, that wheat taken from the wrappings of mummies more than a thousand years old has germinated. The fact is that these accounts were based either on fraud or upon mischievous attempts to obstruct the search for truth. It was a simple matter for fakers to secrete wheat grains in Egyptian tombs and to reveal them, with feigned surprise at the discovery, to the credulous tourist. When the purchaser planted the seed and germination ensued, the vitality of "mummy wheat" seemed to be vindicated. Sometimes, however, the faker dug his own pitfall, as in a cited instance where the cereal found in association with the mummy was not wheat but maize,—a grain which became known to the Old World only with the discovery of America. Carefully conducted experiments to test the germinative powers of wheat have been made by Unger and by other Egyptologists with well preserved seeds of undoubted antiquity, but in no case have the results been other

than negative. The vitality of wheat grains is lost in a very few years.

Claims of marvelous longevity have been made for seeds other than wheat. It is said that raspberry seeds found in a Celtic tomb some seventeen hundred years old and the seeds of black medick, cornflower, and heliotrope discovered in Roman tombs of the second and third centuries, have germinated. Such statements must be viewed with caution Referring to the "incredibly long period" during which the seeds, especially if properly guarded from moisture, of certain species of plants preserve their capacity for germination, Kerner and Oliver state in *The Natural History of Plants*, Vol. I., pp. 51-52: "If after ten years such seeds are transferred into moist earth, the protoplasm in the majority of cases begins to bestir itself and to move, and the embryo grows out into a seedling. After twenty years, perhaps, only about five per cent of the seeds preserved would germinate. The rest are not stimulated by damp earth to further development; their protoplasm no longer possesses the power of augmenting its volume by absorption of matter from the environment, or of developing a definite form, but is disintegrated by the influx of air and water and breaks up into simple compounds. After thirty years hardly one of the seeds would sprout. . . . . Gardeners express the fact by saying the capacity for germination becomes extinct in from twenty to thirty years."

THOUGH the vitality of mummy wheat is an exploded myth, the cereals taken from ancient graves throw interesting light on the antiquity of some of our food stuffs and the method of their preparation. There have recently been presented to the American Museum the mummies of two prehistoric Chilean Indians, an adult and a child, the gift of Señor Recaredo Amengual, Intendente of the Province of Tarapaca, Chile, to whom the Museum is under obligations for many other valued contributions. The mummies were taken from a grave on the outskirts of Pica in the interior of the Province of Tarapaca and among the interesting objects disinterred with them was a bag filled with popcorn, as fresh in appearance as though but just roasted by a street vender. Thus a method of preparing corn that we are apt to associate with a modern picnic or a visit to the circus turns out to have antedated the coming of the white man; indeed among the west coast Indians of South America a specially shaped dish with a depression in the center for the reception of the grains and an attached handle for the comfort of the holder was used in popping corn.

This cereal was not the only object of interest taken from the grave. Close to the surface of the earth was found a parrot placed on a broadly spread, woolen blanket that extended the length of the grave. According to Indian tradition the mission of this parrot was to communicate to the deceased the news of the world from which death had severed him. We have here, then, a curious inversion of the function of the modern medium: it is the dead who through this agency learn of the living, not the living who thus establish communication with the dead.

In addition to the cereal already mentioned and other grains which were intended to support the interred on the journey to the land of eternity, there was a large earthenware jar in which water was placed as refreshment for the trip. The grave contained many other articles of earthenware, wood, wool, and straw, among them being ornaments, wearing apparel, weapons, and even musical instruments. All of these have been presented to the Museum.

In the region from which these mummies were taken, there is no surface indication of the existence of graves. To locate a burying place the searcher must drive a crowbar here and there into the earth. Where the ground proves resistant, there is nothing to be discovered, but if by chance the implement penetrates without great difficulty, a tomb is almost certain to reward the search. After burying their dead with the objects required for their welfare, the Indians filled up the void with loose sand, which even today, after the lapse of centuries, is of a different degree of compactness from that of the surrounding earth.

THE department of lower invertebrates has recently secured through Mr. J. R. Tomlin an excellent collection of shells, consisting of 132 named species from the Loyalty Islands and Singapore. The department has also come into possession, through a bequest of Dr. Titus Munson Coan, of a collection of land snails from Hawaii with accompanying data. These snails, with strongly contrasted bands, are of the family Achatinellidæ and were collected during the years 1851-54, by Dr. Coan, who was born in Hawaii. Snails gathered so long ago are of no little importance, as they may possibly throw light on evolutionary changes since effected. The land snails of Hawaii differ from valley to valley and thus offer opportunity for an interesting study complementary to the monumental work by Dr. Henry E. Crampton on the genus *Partula*, showing the effects of similar segregation in Tahiti.

The most complete collection of Hawaiian land snails is in the Bishop Museum at Honolulu. Dr. Montague Cooke, curator of the Pulmonata in that institution, has found the American Museum's collections of Hawaiian shells of great interest. He has not only thoroughly revised them and brought them to date but he has agreed to amplify and complete them through exchanges from his own collections and those of the Bishop Museum.

THE migrations of birds, while offering unexplained problems, are well-known phenomena; the migrations of butterflies, on the other hand, are occurrences with which the average man is comparatively unfamiliar. In the initial number, bearing date of April, 1921, of the *Australian Museum Magazine*, reference is made to a large-scale migration of the white caper butterfly, *Anaphaeis java* var. *teutonia* (a member of the family Pieridæ to which our common white cabbage butterfly belongs), that took place during November, 1920, in the neighborhood of Sydney, Australia. Similar swarms occurred in New South Wales in 1894, 1903, 1906, and 1909.

In October, 1919, a very noteworthy migration of the yellow butterflies, *Catopsilia statira*, took place in Trinidad. These insects were seen flying, sometimes singly, one or two a minute within the sight of the observer, sometimes to the number of several hundreds during the same interval of time, and sometimes in great clouds of thousands, so dense as to interfere with the progress of a motor car. The rapidity of their flight was no less remarkable than their number. At one time when they were flying over a football field of known dimensions, the opportunity was offered of timing with a stop watch the speed with which eleven butterflies crossed it. An average of their flight-speeds indicated a rate of seventeen miles an hour. It has been estimated that migrating butterflies of the species *Callidryas eubule*, observed in British Guiana in 1917, attained a rate of from twelve to sixteen miles an hour flying across the wind.

In his *Jungle Peace*, p. 158, Mr. Beebe states, speaking of the interesting occurrences at his Biological Experiment Station in British Guiana:

"Even at midday one might sit at a window and take notes continuously of lesser happenings, while now and then something of such note occurred that one could only watch and wonder. This might be a migration of sulphur butterflies, thousands flying steadily toward the southeast, hour after hour, day after day."

Mention should be made of the fact that it is believed by many entomologists that the thistle butterfly, *Vanessa cardui*, migrates every year from the Continent to the British Isles. It has been observed flying at night toward the English coast in the face of a head wind.

In the United States migrations of the monarch butterfly (*Danaus archippus*) have been frequently noted. In the early fall isolated individuals, as well as large groups, sometimes vast swarms, of this familiar flier, conspicuous by virtue of the basic red color on the upper side of its wings, move southward. Their flight has been traced along the coast of Long Island westward toward the mainland, thence to be continued in a southerly direction. The Long Island insect routes have been found to coincide with the local bird routes, and according to Mr. Howard J. Shannon[1], who contributed an interesting article on this subject to *Harpers Monthly* in September, 1915, "suggests the probability that such parallel movements are in the nature of a general law." The migrations of the monarch are of particular interest in that a return flight of individuals takes place from the south in the spring. These bedraggled pilgrims have been observed coming with tattered wings to reëstablish the northern population. Where do they sojourn during the months when their summer habitat is encased in snow? This is one of the many puzzling questions connected with insect migration that still await solution.

Among the most striking exhibits in the hall of insects on the third floor of the American Museum is a gathering of monarch butterflies during the migrating season. Over one thousand specimens are shown clustering on the leaves and branches of an oak tree. The exhibit is based on actual observations. In fact, much larger assemblages of monarchs have been reported. In the *Canadian Entomologist* for April, 1916. Mr. R. P. Dow tells of coming upon a swarm of the monarch at Rockaway Beach, Long Island. "They were numb with cold and easy to pick as blackberries. A day's work would have included not less than, say, 20,000 of them."

In striking contrast to the normal abundance of this species, it should be noted that during the past three years it has been of very limited occurrence in the neighborhood of New York, only an occasional isolated individual having been observed. This circumstance adds but another perplexity concerning the activities of this interesting insect.

MR. GEORGE K. CHERRIE, inveterate collector in the tropics of America, who has to his credit more than thirty trips made in the interests of science to the southern continent, and who was the companion of Roosevelt in the exploration of the River of Doubt, sailed on June 18, for Ecuador, to supplement the work he accomplished there in 1920 in coöperation with Mr. H. E. Anthony, of the department of mammalogy, American Museum. Mr. Cherrie is accompanied by Messrs. Gill and Tate, the former being engaged with Mr. Cherrie in the collecting of birds, the latter devoting himself to the obtaining of mammals. Later in the season Mr. Cherrie will extend his field work to Peru.

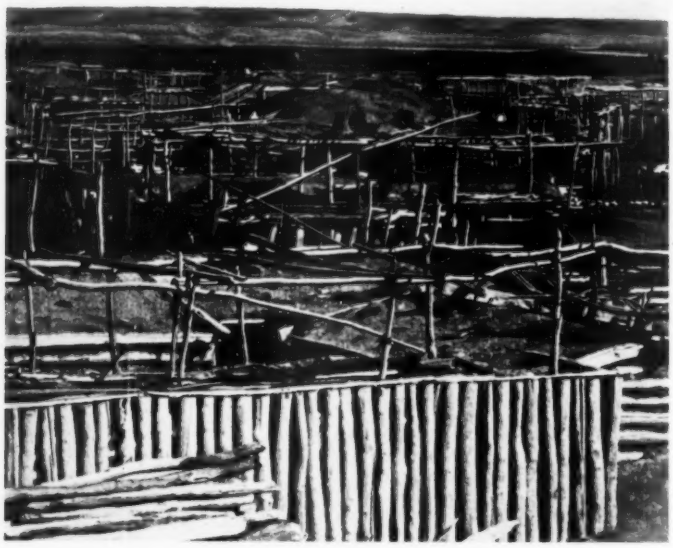
DR. P. E. GODDARD, curator of ethnology, American Museum of Natural History, has

[1]For an interesting account of the migrations on Long Island not only of the monarch but of other species as well see an informing article entitled "Autumn Migration of Butterflies" by Howard J. Shannon in the AMERICAN MUSEUM JOURNAL for January, 1917, pp. 33–40.

THE MONARCH BUTTERFLY MIGRATING

This exhibit on the third floor of the American Museum illustrates a gathering of monarchs during their southward flight in the fall. More than 1500 butterflies, 600 of which were collected by Miss Almeda Johnson, are assembled in this exhibit, which is based on observations made by Mr. G. H. Sherwood, at Clinton, Connecticut, and by Mr. H. J. Shannon at Easthampton, Long Island. Each insect had to be mounted especially for the purpose,—a task requiring no little skill and patience on the part of Mr. Charles Wunder, to whom this work was entrusted. The accessories were made and assembled by Mr. W. B. Peters. Vast as is the number of butterflies represented in this exhibit, even larger gatherings have been noted in nature

been visiting the Indian reservation located at Fort Berthold, North Dakota. On this reservation are gathered remnants of three tribes, the Mandan, Hidatsa, and Arikara, the last mentioned a Caddoan people closely related to the Pawnee. All of these Indians are known as builders of earth lodges. The Arikara had not erected any for so long a time, however, that the recent completion by them of such a lodge was regarded as an event to be celebrated with a full accompaniment of time-honored ceremonies. The lodge was dedicated to Professor Melvin R. Gilmore, curator of the State Historical Society of North Dakota, and it was at his invitation that Dr. Goddard attended in order to make a record of the ceremony. Miss Gladys A. Reichard, assistant in anthropology at Columbia University, collaborated with Dr. Goddard in securing the ritual. Dr. Goddard took with him a moving-picture camera to put on record the dances and ceremonials that were engaged in, and a phonograph for the registering of the songs. These adjuncts are invaluable, for the poses and nervous responses of an Indian during the performance of a ceremony are made real through the moving-picture camera, while the inflection of the voices can be conveyed only through some such medium as the phonograph.



Hidatsa Village in 1868.—The low, earth-covered lodges are obscured by the poles of drying-frames. (Morrow photograph reproduced by F. N. Wilson and published in *North American Indians of the Plains* by Clark Wissler)

Dr. Hiko Matsumoto, who until a few weeks ago was studying the Fayûm collection of Proboscidea in the American Museum, recently received the Imperial Institution Prize, one of two highly valued prizes of the Imperial Institution of Science and Literature of Japan. This award is bestowed on contributions to the science and the literature of the world, and Doctor Matsumoto's work on the Ophiuroidea, an echinoid group known as brittle-stars, received this recognition His works on the subject are entitled *New Classification of Ophiuroidea, with Descriptions of Some New Genera and Species* and *Monograph of Japanese Ophiuroidea, Arranged According to a New Classification.* Doctor Matsumoto's new classification is based upon anatomical studies of all the principal genera of this class and has been accepted in the United States and France. He spent nine months working in the American Museum and during that period completed a revision of the Proboscidea and Hyracoidea collected by the American Museum Expedition to the Fayûm of Egypt in 1907. From America he went to England to continue his studies at the British Museum, where the original collections of the wonderful mammals of the Fayûm are preserved.

Dr. Clara Barrus, literary executor and authoritative biographer of the late John Burroughs, asks that all persons owning interesting letters from Mr. Burroughs communicate with her at Woodchuck Lodge, Roxbury, New York. All letters sent will be promptly

copied, or extracted from, and returned to the owners.

THE whole of the Hawaiian volcano district has passed under the control of the National Park Service and an appropriation of $10,000 has been made by Congress to defray the expenses for the year. This is an amount too small to enable those in charge properly to do the things that should be done in the district, and it is to be hoped that, made aware, through articles like that of Dr. T. A. Jaggar, Jr. in the present issue, of the immense importance of this region to science, more adequate funds will be voted in subsequent years. Interesting discoveries are constantly coming to light in this region, which while of primary significance to the volcanologist, is not without importance also to the anthropologist. In the Kau Desert, far to the south of Kilauea, was found an old Heiau, or temple, overlooking the ocean, and near it interesting petroglyphs. Recently word reached the American Museum that there had been discovered "a very remarkable series of ancient footprints in the lava district of Kau." These will be protected from possible injury by the casual tourist.

THE first session of the new Institut International d'Anthropologie was held under the presidency of Prince Roland Bonaparte at Liége, Belgium, during the closing days of July. This is the first anthropological congress of an international character that has gathered since the war and is auspicious also in being accorded the patronage of the Belgian government. The program of work was divided into eight sections, as follows: physical anthropology, prehistoric archæology, comparative ethnography, criminology, eugenics, religion and mythology, linguistics, and psychology and sociology. Included in the program were excursions to the Campignian deposits of the Province of Liége, to the Upper Paleocene of Martinrive, to the camp station of Hesbaye, to the Neolithic stations of Sainte-Gertrude, and a visit to the archæological museum at Namur. The proposed aim of this new association, in which a number of American archæologists are enrolled as members, is to help unify and improve all phases of anthropological technique.

DR. WILLARD G. VAN NAME, assistant curator of the department of lower invertebrates, American Museum, has recently been appointed assistant secretary of the Executive Committee on Natural Resources, which is a union of the committees appointed by the National Academy of Sciences, the National Research Council, and the American Association for the Advancement of Science. The purpose in organizing this Executive Committee is "to promote, by scientific effort and through education, the most reasonable use of our natural resources for the economic, industrial, and social development of the country." It will advise, coördinate, and strengthen existing organizations formed in the interests of conservation, to the end that the most effective results may be obtained.

THE dependence of man on the forests is so obvious as to be a truism. To them we are indebted for the chair we sit upon, the newspaper we read, the table from which we eat, the floor on which we tread, the very roof over our heads. They regulate the stream flows and thereby prevent disastrous floods. Their restful beauty restores the harassed souls of men. And yet, our forests are being destroyed at an alarming rate,—destroyed not merely by the axe to supply more or less legitimate needs but. without any compensating consideration, by fires that in the majority of cases are preventable. In the five years ending with 1920 the total loss from forest fires exceeded $85,000.000. The area burned over during that period totaled 56.488,000 acres, an area greater than that represented by the New England States together with all the forested region of the state of New York. This destruction was caused by no less than 160,000 fires, more than 60 per cent of which, due to human agencies, could have been prevented through the exercise of proper precautions. Not only has there been material loss, human lives have not infrequently been sacrificed too. In the great Minnesota fire of 1918 nearly a thousand persons were burned to death or suffocated. As much as $2.500,000 is annually expended for the detection and suppression of forest fires; of this sum more than $1,000,000 is spent by the Forest Service of the United States Department of Agriculture, the remainder by the states and by private individuals. It is obvious that the exercise of greater care and vigilance on the part of all citizens would admirably supplement the fire prevention work that is being done and so assist in conserving an indispensable product.

THROUGH an unfortunate oversight for which NATURAL HISTORY takes full responsibility, credit was not given to Dr. W. R. Taylor for the attractive picture of "A growth of *Purpurea* near Tom's River, New Jersey," which appeared on page 316 of the May-June issue. NATURAL HISTORY on behalf of itself and of Mr. Frank Morton Jones, author of the article "Pitcher Plants and Their Moths," in connection with which the illustration was used, desires to make grateful acknowledgment of Dr. Taylor's courtesy.

THE department of herpetology, American Museum, has recently secured through the

efforts of Mr. Barnum Brown, of the department of invertebrate palæontology, a magnificent collection of reptiles and amphibians from a particularly interesting section of Africa. Except for the herpetological specimens secured by the American Museum Congo Expedition under the leadership of Mr. Herbert Lang, this collection represents the largest acquisition the department has ever obtained from that continent.

Other departments, too, have been benefited by Mr. Brown's collecting. Among the specimens he shipped to the Museum are approximately 50 fish, about 600 crustaceans, mollusks, and echinoderms, and some 500 insects.

A fine series of fossil invertebrates was also contained in Mr. Brown's shipment. Some of the fossils are very ancient, representing the remains of organisms which lived in the Devonian period of the Palæozoic. Most of them, however, are more recent and come from the Jurassic period of the Mesozoic. They include many genera of ammonites, almost every specimen belonging to a distinct genus, and a large number of brachiopods, pelecypods, gastropods, and echinoderms, the entire fauna ranging in age through the Middle and Upper Jurassic and possibly down into the Lower Jurassic. The collection is valuable biologically because it contains many new species, and stratigraphically because it will fill in one of the gaps in the geological column. It is by this process of gathering new data in regions which have been little studied that we obtain our knowledge of the extent of ancient lands and seas and of the distribution of the marine faunas of the past.

ANOTHER recent example of splendid interdepartmental coöperation is the collection made for the department of herpetology by Mr. H. E. Anthony, associate curator of mammals of the Western Hemisphere and leader of the American Museum Expedition to Ecuador. Notwithstanding the large claims which his field work in mammalogy made upon his time and energy, Mr. Anthony succeeded in bringing back with him from South America an extremely interesting and well-preserved series of reptiles and amphibians.

The American Museum is such a large institution that specialization in field work has been the rule. General collecting is still the chief method in smaller institutions such as the Museum of Comparative Zoölogy in Cambridge. The work of Mr. Anthony, as well as that of Mr. Brown referred to in the previous note, demonstrates to what excellent advantage a specialist may turn his leisure moments. A similar spirit of coöperation is inspiring the members of the American Museum's Third Asiatic Expedition under the leadership of Mr. Roy Chapman Andrews, and there is good reason for believing that they will secure a series of specimens representative of all phases of the animal life of the region visited.

Two papers that supplement one another appeared in a recent issue of the *American Anthropologist*. They are contributed by Dr. P. E. Goddard, curator of ethnology in the American Museum, and by Mr. Louis R. Sullivan, assistant curator of physical anthropology in the same institution. In his paper on "The Fossa Pharyngea in American Indian Crania" Mr. Sullivan shows that the fossa pharyngea—a rare structural feature if one considers the world as a whole—occurs with rather high frequency in certain crania from our Southwest and from Mexico. The distribution of these crania corresponds quite closely with the area occupied by the Uto-Aztecan linguistic stocks and by the culture of the Basket-maker. Doctor Goddard in his paper, entitled "The Cultural and Somatic Correlations of Uto-Aztecan," states that Mr. Sullivan has established "a definite physical group having a common line of inheritance, and points out some of the problems which an extension of Mr. Sullivan's investigations may solve. "With a physical type definitely correlated with Shoshonean speech it ought to be possible to determine whether any considerable number of such a physical strain were incorporated in the Shoshonean-speaking Hopi villages. If a definite physical type can be established for the stone-house-building peoples of the San Juan drainage it should be possible to trace the movement of the people themselves as well as their culture. This is especially promising since types of pottery of definite geographical and temporal sequence have been established." To arrive at his conclusions Mr. Sullivan examined no less than 2517 crania in the collections of the American Museum.

THE peculiar geographical distribution of the various species of penguins (Sphenisciformes) is explained by Dr. Maurice Boubier[1] by reference to the movements of the Antarctic ocean currents. This avian family, originally of the south polar regions and adapted to cold-water conditions, now extends to the Galápagos Islands on the equator, off the west coast of South America; to Rio Grande do Sul in southern Brazil (about 30° south latitude); to Walwich Bay or Cape Frio on the west coast of Africa (about 16° south latitude); and to about 22° south latitude on the western coast of Australia. They are notably absent along the eastern coasts of Australia and Africa, and on the eastern coast of South America extend nowhere nearly so far north as on the western.

The explanation, according to Doctor Boubier,

[1] M. Boubier, "La distribution géographique des manchots (Sphéniscidés) et son interprétation géophysique." *Revue Française d'Ornithologie*, 11e Année, No. 126-27, 1919, pp. 131-36.

is to be sought in the distribution of currents derived from the great Antarctic circumpolar drift. This travels from west to east and where it impinges upon the continents north of Cape Horn, the Cape of Good Hope, and Cape Leeuwin, Australia, it is deflected northward along the western coasts of the three southern continents to form the Peruvian, Benguela, and West Australian currents, respectively. There is also a cold current hugging the eastern coast of Argentina and Uruguay. Not only do these cold currents maintain a low surface temperature in the sea in these localities, and also probably assist in reducing the air temperature (the isotherm of 20° centigrade roughly limits the distribution of penguins), but, what is more important, they transport an enormous mass of Antartic plankton on which the birds feed. The organisms constituting this plankton live only in the cold waters, so that when the currents become warmed by traversing tropical seas before returning south (as along the eastern coasts of the southern continents), they lose their Antarctic plankton. Penguins are accordingly absent along these coasts.

As pointed out by Dr. R. C. Murphy, who has devoted special attention to the effects of the Humboldt Current, these statements, while correct as regards the main thesis of penguin distribution, nevertheless tend to perpetuate a common error: The low temperature of the currents in question is due not to the transportation of surface water from high latitudes, but solely to the *upwelling* of cold bottom waters. This upwelling, for reasons proceeding from the eastward rotation of the earth, is very marked, and very uniform, along great stretches of the western continental coasts. The vertical circulation brings to the surface a vast abundance of food in the form of the remains of organisms which had previously settled to the bottom over wide areas of the ocean. Thus the low temperature and the plentiful primary nutritive resources combine to make suitable life conditions for the kinds of crustaceans and other creatures upon which penguins feed. The conception of great oceanic "rivers," bearing northward the cold water and living cargo of Subantarctic seas, is quite erroneous. The currents are at best very slow moving compared with rivers, for instance. The organisms that inhabit them do not originate in the far south, except perhaps in an evolutionary sense, but are born, live, and die, in the latitudes where they are found. It is not, in short, that the currents carry individual organisms across the temperate zones and into the tropics, but, rather, that the vertical circulation produces life conditions in narrow littoral belts which resemble those of the Antarctic and Subantarctic seas. These belts, which are mostly on the western coasts of the continents, are therefore inhabited by Antarctic or Subantarctic groups of animals, of which the penguins are but one striking example.

"NATURAL HISTORY"

SEPTEMBER–OCTOBER ISSUE

SOUTH AMERICA,—land of strange contrasts, of desert wastes and tropical abundance, of sky-piercing mountains and low-lying jungles,—is a region to which interest is bound to turn increasingly. Its little-traversed areas are a tempting field for the naturalist; its native tribes offer rare study material for the anthropologist; its ancient west coast civilization, the consummation of pre-Columbian culture, has an abiding glamour even when viewed with the calm eye of science, unaided by the colored glasses of romance. It is this west coast region that will have especial emphasis in the issue of NATURAL HISTORY for September-October.

The leading article is devoted to the wonderful collection of Peruvian gold that has recently come into the possession of the American Museum. One is wont to associate gold exclusively with the Incas but other peoples of this interesting region also employed the precious metal for the fashioning of utensils and ornaments. The gold described is of the Chimu kingdom and includes water vessels and plates, hair ornaments, and impressive breast plates large enough to extend from shoulder to shoulder if worn by a man. These treasured acquisitions are described by DR. P. E. GODDARD, curator of ethnology, American Museum, who recently visited the site of their discovery. The article is accompanied by illustrations in color, making more graphic the beauty of form and of workmanship that these objects evidence.

Owing to the contrasting conditions of aridity and extreme moisture encountered as one moves from the west coast of South America to the Oriente, or eastern slope of the Andes, the diverse life zones resulting are of particular interest. MR. H. E. ANTHONY, associate curator of mammals of the Western Hemisphere, who returned not many months ago from his expedition to Ecuador, contributes a vividly written article regarding the influences of temperature and humidity on the distribution of plant and animal life in the region visited. The article is illustrated with unusual photographs.

A valuable contribution to the ornithology of South America, issued under the title of "*The Distribution of Bird Life in the Urubamba Valley of Peru*," by Dr. Frank M. Chapman, curator of ornithology in the American

Museum, is reviewed by Dr. Robert Cushman Murphy, associate curator of marine birds. In the work specified Dr. Chapman presents a report on the birds collected by the Yale University–National Geographic Society's Expeditions to the region indicated.

The fauna of the Andes includes few creatures so interesting and at the same time so perplexing as the marsupial frog, the female of which carries her eggs about with her in a pouch that is located on her back. How do the eggs get there? Does the male assist his mate in placing them in this curious receptacle? These are questions still awaiting an answer; but a great deal of light on the habits and ways of these amphibians is shed in the course of Mr. G. Kingsley Noble's article entitled "A Search for the Marsupial Frog,"—a search that yielded many other desirable creatures in addition to the animal that was the especial object of pursuit. The expedition with which Mr. Noble, who is assistant curator (in charge) of herpetology, was connected, traversed a region full of varied interest, the diverse scenes of which have fortunately been registered with rare fidelity by Mr. Noble's camera. A selection from these photographs constitutes a fine pictorial series supplementing the article.

Another section of the Andean region is delightfully described by Dr. Edward W. Berry, who made a trip *a loma de mula* from La Paz, the highest capital in the world, to the eastern rain-forest slopes of the Andes of northeastern Bolivia, a region known as the Yungas and rightly characterized by Mr. Berry as "a veritable naturalist's fairyland." Striking pictures of the Andes accompany this article.

Having glimpsed in these several narratives representative sections of the west coast, the reader is next taken along the Rio Negro, one of the confluents of the Amazon, to sojourn among the copper-skinned Caboklas, who, notwithstanding the evil reputation that some writers have given them, befriended and treated with generous hospitality Mr. William T. LaVarre, who for several months lived among them and who in a brightly written article recalls the impressions of that sojourn.

Tapioca, one of the products for which the world is indebted to the Indians of South America, is a food with which most people are familiar, yet regarding the derivation of which few can give the correct answer. In an interesting article Mr. Charles W. Mead, assistant curator of Peruvian archæology in the American Museum, supplies information regarding the nature of tapioca and the method of its preparation.

The Second International Congress of Eugenics gathered at the American Museum of Natural History during the last week in September. It was attended by scientists from all parts of the world, eager to exchange views on a subject of all-eclipsing importance. Several foreign governments sent their diplomatic representatives. No phase of eugenics was overlooked in the thoughtful and informing addresses that were delivered in the course of the session. The exhibit conducted in connection with the Congress was a feature of unusual interest. It is the hope of Natural History to accord due space to these activities in its next issue.

Dr. Joel Asaph Allen, who recently died, rich in accomplishment as in years, was the dean of the faculty of the American Museum, in the interests of which he labored devotedly. Appreciations of his personality and his work are in course of preparation.

With the recent visit to this country of Madame Curie, radium is more than ever a subject of general interest. This miracle-working mineral, in many respects the supreme marvel of nature's storehouse, is to most people a baffling enigma. To convey essential information regarding radium—the minerals in which it is found, the way it is produced, the uses to which it is put—Dr. George F. Kunz, president of the New York Mineralogical Club and research associate in gems of the American Museum, some months ago directed the installation of a radium exhibit in the Museum, which attracted the attention of all those who visited the institution. That the instructive data presented in this exhibit may be placed on record, Dr. Kunz is preparing an informing article, accompanied by illustrations, describing the exhibit and its significance.

A series of pictures of Miocene fish, restored under the direction of Dr. David Starr Jordan, has especial interest in that these fish are the immediate ancestors of certain marine fish of today.

"Glimpses of the Home Life of the Saw-whet Owl" is the appropriate title of an article contributed by Messrs. Robert B. Rockwell and Clark Blickensderfer. Readers of Mr. Rockwell's "Trials and Tribulations of a Nature Photographer," which appeared in the issue of Natural History for March-April, 1920, will appreciate the fact that no effort has been spared in depicting this interesting owl, which long eluded the most painstaking search of the authors. The photographs illustrating the article give an intimate picture of the behavior of the young birds and their parents in the family circle.